This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Rec'd from Bindery Nov. 4, 1920

Harvard College Library

LIBRARY OF THE
CHEMICAL DEPARTMENT

SCIENCE CENTER LIBRARY

CHEMISTRY LIBRARY,
HARVARD UNIVERSITY
DISCARDED

Chemical & Metallurgical Engineering

A Technical Newspaper,
Being the Incorporation of
Electrochemical and Metallurgical Industry
and Iron and Steel Magazine

Volume XXI

From July 1 to December 31, 1919

This volume of Chemical & Metallurgical Engineering is complete in fifteen numbers owing to the fact that certain numbers so designated on their individual contents pages have been combined.

NEW YORK:
McGRAW-HILL COMPANY, Inc.

INDEX TO VOLUME XXI

GENERAL ALPHABETICAL INDEX

	PAGES.
July 1	1 to 56
July 15	57 to 112
Aug. 1	113 to 162
Aug. 15	163 to 218
Sept. 1	219 to 268
Sept. 15	269 to 412
Oct. 1	413 to 444
Oct. 8	445 to 476
Oct. 15	477 to 508
Oct. 22	509 to 540
Oct. 29-Nov. 5	541 to 604
Nov. 12-Nov. 19	605 to 652
Nov. 26-Dec. 3	653 to 700
Dec. 10-Dec. 17	701 to 748
Dec. 24-Dec. 31	749 to 796

A

Absorption tower packing. Resistance to gas flow. Zeisberg. 765
Acetates from starchy material. Fernbach. (B.P.) 695
Acetic acid, Acetone from. Curme. (P.) .. 743
——Extraction from aqueous solutions. Morris. (B.P.) 472
——From calcium carbide. Matheson. (S.) 578
Acetone from acetic acid. Sedgwick and Lambert. (B.P.) 742
——From acetic acid. Curme. (P.) 743
——From calcium carbide. Matheson. (S.) 578

ACID:

——Mineral acid production in U. S..... 68
——Sludge, Distillation of. Hechenbleikner and Gilchrist. (P.) *212
Acid-proof materials:
——Acid-proof apron 581
——Brick and tile in chemical plants. Stevens. (N.) 468
Agricultural research, Problems of. Wheeler. (N.) 279
Air compressors, Ingersoll-Rand, small type *204

ALCOHOL:

——Higher alcohols. Richmond. (N.) .. 558
——Industrial Alcohol Act 39
——Industrial, Future of. Tunison. (N.) *557
——Industrial, Symposium on. *557
——For fuel. Lopez. (Aust. P.) 790
——From sulphite waste liquor. McKee. (N.) 558
——From wood waste. Kressman. (N.) 558
——Uses of. Chart. *559
——Wood alcohol—Co-operative caution. Baskerville. 733
Alaska, Mineral production in 1918. 752
Alberger salt process 331
Albone (Hydrogen peroxide, 25 per cent by vol.) 456
Algin, Production of. 261
Allen-Moore cell in paper mill. Mitchell. *370
Allis-Chalmers forge shop. *576
Allis-Chalmers new type D-C motors and generators. *644

ALLOYS:

——Alloy which resists molten brass and bronze. Kinnison. 608
——Aluminum, Effect of amalgamation on single potential of. Kahlenberg. 522
——Apparatus to prevent volatilization. Burr. (P.) *643
——Biakmetal, New Cu-Zn. 632
——Carbon-free, Electric production of. Northrup. *258
——Experience with a 91-9 Cu-Al alloy. Krynitzky *770
——For glass molds. Milliken. (P.) ... 210
——Manganin, Study of. Hunter and Bacon. (N.) 520
——Molybdenum-tungsten. Keyes. (P.) 211
——Non-ferrous. Melting in electric furnace. Collins. *673
Alloys Research Association, Preliminary note 457
——Plan of organization 753
Alpha naphthylamine-xylidine flotation agent. 418
——Correction. 565
Alumina, Production of (N.A.E.I.) (B.P.) 405

ALUMINUM:

——Copper-aluminum (91-9) alloy. Krynitzky. *770
——Metallography of aluminum ingot. Anderson *229
—— Corrections. 277
——Single potential of, Effect of amalgamation on. Kahlenberg. (N.) .. 522
——Solders for (S.) 101
——Use as electrical conductor in Germany *740
Aluminum bronze, Influence of heat-treatment on microstructure. Seidell and Horvitz *179
Aluminum chloride, Mfr. of. Dutt. (B.P.) 472
Aluminum salts, Purifying. (N.A.E.I.) (B.P.) 405

AMERICAN CERAMIC SOCIETY:

——Chicago meeting. Program. 299
—— Report. 462
——Past, present and future of. Binns. (N.) 464
American Chamber of Commerce in London to send commission to Germany. .. 170

AMERICAN CHEMICAL SOCIETY:

——Philadelphia meeting. Announcement 61
—— Program 226
—— Report *278
—— Industrial excursions. *488

AMERICAN ELECTROCHEMICAL SOCIETY:

——Chicago meeting. Program 65
—— Program, Complete. 295
—— Report. 520
——Boston meeting (1920) Announcement 686

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS:

——Boston meeting. Report *5
——Savannah meeting. Program. 547
—— Report *660
—— Photograph of members 711

AMERICAN INSTITUTE OF METALS:

——Philadelphia meeting. Report. *550

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS:

——Chicago meeting. Announcements 24, 128, 167, 170
—— Program. 296
—— Report. 458
——Dinner to Herbert C. Hoover. Report. 419

AMERICAN IRON AND STEEL INSTITUTE:

——New York meeting. Report. 545
Americanization work in Newark, N. J... 375
American Petroleum Institute 486

AMERICAN SOCIETY FOR TESTING MATERIALS:

——New headquarters. 428
——Standards adopted in 1919. 527

AMERICAN STEEL TREATERS' SOCIETY:

——Chicago convention. Announcement. 61
—— Program. 299
—— Report. 530
American Zinc Institute meeting. 29
America's case in chemistry. Hendrick... 684
Aminocymene, Production and use. Andrews. (P.) 743

AMMONIA:

——Cost of manufacture at U. S. Nitrate Plant No. 2. 66
——Extraction from gases. Pease. (B.P.) 102
——In producer gas. Ovitz. 253
——Nitrogen oxides from. Maxted and Ridsdale. (B. P.) 694
——Oxidation of. Establissements Kuhlmann. 4
——Synthesis by new process. (S.) ... 438
——Synthetic. Briner and Baerfuss. (B.P.) 579
Ammonium nitrate, Cost of manufacture at U. S. Nitrate Plant No. 2. 66
Ammonium perchlorate explosives. (B. P.) 742
Anaconda Copper Mining Co., Chimney at *609

ANALYSIS:

——Electrochemical, Rapid apparatus for. King. *25
——Gas, By interferometer. Edwards. .. 560
——Gas, Improved Orsat apparatus for. Jones and Neumeister. *734
——Gases in steel. Cain. (N.) 459
——Of gas mixtures by interferometer. Pouchon. 392
——Red lead. Ericson. 61
——Red lead. Literature. Schaeffer... 274
——Silicate rock. 565
——Steel. Sulphur and chromium in. Goldenberg. 628
——Zinc dust. Metallic zinc in. Edwards. 192
Anhinga fiber industry 785
Anthracene plant. Barrett Co. 496
Antimony ores, Treating. Hulst. 727
Anti-tuberculosis campaign. 659
Apron, Acid-proof. 581
Asphalt industry. Miller. (N.) 705
Asphalt, Melting point of. Proctor..... *81
Atomic structure of metals in solid solution. Feild. *566
Atoms, Constitution of. Harkins. (N.) 280
Atoms, Constitution of, Langmuir's theory. Hendrick. *73
Australia, Gold production. 473
Austria, Magnesite industry in. 671

B

"Ball and ring" method for m. p. of asphalt 82
Barcelona, Plans for 1920 sample fair... 440
Barrett Co., Frankford works. 493
Bates College, Jordan Scientific Society. .. 194

BATTERIES:

——Primary:
—— Dry cells, Depreciation of. Helfrecht. (N.) 520
—— Manganese dioxide in dry cells.... 196
—— Manufacture of dry cells. 196
——Secondary:
—— Mfr. at Electric Storage Battery Co. 490
Beckman & Linden Eng. Corp., Silicomanganese furnace. *752
Beet sugar: (see Sugar, Beet.)
Belgian commercial museum wants samples 623
Belgian steel trust proposed............ 741
Belgian wage scale. 726
Belgium, Metallurgical situation in 154
——Production statistics: (see Production statistics).
——Zinc industry. Chase 571
Benzene, Continuous rectification of. Baril, (S.) *693
Benzene stills. Barrett Co.............. *494
Beryllium: (see Glucinum.)
Bessemer process (see Iron and Steel, Processes)
Beverage Exposition *706
Biakmetal, New Cu-Zn alloy. 632

BIBLIOGRAPHIES:

——Casein and casein glues. 138
——Gasoline-kerosene mixtures, flash points, etc. 252
——Glue, Animal and casein 138
——Shellac. 721
Black liquor ash, Sodium hydroxide from. McAfee. (P.) *256
Blast furnace: (see also Iron and Steel, Furnaces.)
Blast-furnace gases, Recovery of potash from, In England. Hibbert. 728
Blast-roasting: (see Roasting)
Blood albumin. Jerwen and van Hoogenhuzze. (B.P.) 404
Blood albumin glue. 136
Bolivia, Tin in. Reyes. 60

BOOK REVIEWS:

——Betts. Timber: Its Strength, Seasoning and Grading. 645
——Commons. Industrial Goodwill...... 646
——Hendrick. Opportunities in Chemistry. 155
——Hodgman. Handbook of Chemistry and Physics. 645
——Hofman. Metallurgy of Lead. 103
——Leech. Chemists' First-Aid Treatment. 535
——Paul. Boiler Chemistry and Feed Water Supplies. 50
——Scott. Journal of the Institute of Metals, vol. XXI. 440
——Scott. Qualitative Chemical Analysis. 646
——Spencer. Metals of the Rare Earths. 646
——Vedder. American Methods in Foreign Trade, A Guide to Export Selling. 262
——Condensed Chemical Dictionary. 535
——Directory of the Chemical Industries in Canada. 646
——Year Book of the Coke Oven Managers Association. 791
Booth electric rotating furnace. Booth.. *636
Boxes, Packing, Designing and Testing... 762

BRASS:

——Cost of melting in fuel fired and electric furnaces.............. 677
——Electric contact arc resistance type furnace for. *674
——Electric furnaces for. Gillett. (N.). 6
—— Correction. 116
——Electric resistance furnace for. Baily. (N.) 11
——Electric rocking furnace for. St. John. (N.) 13
——German founding methods. 754
——Recovering. White. (B.P.) 580
Brass itch, To relieve. 502
Briquetting pulverized iron ore. Lammerhirt. (P.) 694
——Sawdust prior to distillation. *193
Brick: (see Refractories.)
British Association for Advancement of Science:
——Bournemouth meeting. Report. Kershaw. 531
British Columbia, Metallurgical activity... 166
British electrodes. (S.) *641
British government aids dye trade. 170
British Potash Co. 723
Bronze, Aluminum, Influence of heat-treatment on microstructure. Seidell and Horvitz *179

*Illustrated; (P.), (B. P.), (Aust. P.), (Can. P.)—United States, British, Australian and Canadian patents, respectively; (S.)—Synopsis; (N.)—Papers read at society meetings but not printed in full.

Brussels, Commercial fair. 556
Bureau of Chemistry, Chemicals received during war. Buc. (N.) 288
Bureau of Mines:
——Electric furnace laboratory. Grier. *574
——Dr. R. B. Moore appointed chief chemist. *548
——Pittsburgh Station. Thum. *432
—— Dedication. *545
Bureau of Standards:
——Research problems before. 427
Burning points of gasoline-kerosene mixtures. Robson and Withrow. *244
Burton process stills. *489

C

Calcium bisulphite, Mfr. of. Hinzke. (P.) *209
Calcium carbide, Acetic acid and acetone from. (S.) 578
Calcium carbide conversion calculations. Knapp. 139
Calcium nitrate. Smith and Ammonia Soda Co. (B.P.) 694
Calcium superphosphate. Gaillard. (B.P.) 455
Calorimetry:
——Adiabatic bomb calorimeter. Holland. Reed and Buckley. *191
——Calorimeter efficiency. White. 187
Canada Copper Corp., New plant. 166
Canada, Iron and steel production, 1918. 117
——Waterpower resources, Investigation of. 63
Carbide: (see Calcium carbide.)
Carbolic acid: (see Phenol.)
Carbon, Activation of. Chaney. (N.) 520
Carbon bisulphide, Recovery from benzol. Dow. (P.) 694
Carbon black, Properties and uses. Perrott. (N.) 292, 430
Carbon tetrachloride, Chloroform from. Dow and Quayle. (P.) 403
Carnegie, Andrew. Obituary. *168
——United Engineering Society resolution. 227
Casein glues. 137
Castor bean crop, Government assumes responsibility for failure. 728
Catalysis, Symposium on. Bancroft, Taylor, Huff and Rideal. (N.) 522
Caustic potash: (see Potassium hydroxide.)
Caustic soda: (see Sodium hydroxide.)
Celluloid substitute. Clarke. (P.) 212
Cellulose nitrate composition. Clarke. (P.) 212
Cellulose solvent. Ostenberg. (P.) 743
Cellulose, Solution in thiocyanates. Manchester Oxide Co. et al (B P.) 580
Cellulose symposium, N.Y. Sect., A.C.S. 708
Census of manufactures, Plans for. 714
Ceramic engineering, Short course at U. of Ill. 681
Ceramics, Making of pottery. Rhead. (N.) 468
Cerium, Commercial, Mfr. by Welsbach Co. *501
Charcoal, Vegetable, From pine needles. Penrose. (B.P.) 579

CHARTS:

——Alcohol, Uses of. *559
——Alignment:
—— For Gas laws. Wikoff. *195
——Atomic weights, melting points, etc. 692
——Electrolytic chlorine cell calculations. Horine. 71
——For chemical works. 692
——Forest Products Laboratory, Organization. 759
——Fuel composition. Schreber. *579
——Gas combustion. Grebel. (S.) *641
——Hydrometer calculations. *396
——Relative values of Cu, Al, Zn and Fe as electrical conductors. 740
——Temperature conversions. 692
——Thermal expansion of optical glass. 670
——Thermocouple calibration curves. 85
——Tungsten, Uses of. 201
Chemical engineering fellowships at Columbia. 63
Chemical equipment at Beverage Exposition. *706

CHEMICAL INDUSTRY:

——America's case in chemistry. Hendrick. 684
——Chemistry and the South. Little. 710
——Economic status of American. Breithut 129
——English, Present status of labor in. Marshall. 16
——Exposition of:
—— Exhibitors, List of. 119
—— Exhibits, Descriptive list of. 300
—— Observations made at show. 456
—— Preliminary report. 427
—— Programs of meetings. 294
—— Report. 449
——German, Military importance of. 225
——Government ownership of water power in relation to electrochemical industry. FitzGerald. 95
——Illinois and Chicago district. Thomson. *315
——In China. 785
——Indiana, Anderegg. *324
——Japanese, Progress in. Annebault. (S.) 208
——Michigan. Badger. 330
——Wisconsin. Kowalke. 338
——World-wide problems of. Grossmann. (S.) 470
Chemical market; 51, 106, 158, 214, 263, 406, 442, 504, 536, 583, 590, 593, 596, 599, 602, 648, 696, 744, 792
Chemical nomenclature and spelling. Parsons and Negru. 544
Chemical plants, An innovation in insurance for. 754
Chemicals, Prices of during war. Breithut *174
Chemical technology for college students. Grossmann. 4
Chemical warfare in France. Zanetti. (N.) 533

CHEMICAL WARFARE SERVICE:

——American Chemical Society resolution. 278
——American Electrochemical Society resolution 707
——Army reorganization bill discards. 169
—— Senator Chamberlain's criticism. 473
——Criticism of Senate Bill 2715, 66th Cong. 608
——Employment service. Crossett. 613
——General Sibert's testimony. 707
——Present strength of. 610
——Recruits wanted. 709
——War Department deserts. Freud. 274
—— Fries. 416
Chemist, Relation to manufacturer. O'Leary. 450
Chicago Beverage Exposition *706
Chicago Chemist Club. 776
Chicago district:
——Chemical industries of. Thomson. *315
——Industrial resources. *310
——Iron and steel plants. Thum. 319
——Non-ferrous metallurgy in. Pulsifer. *310
Chicago Electrical Show *708
Chicago section, A. C. S.:
——Directory of members. 611
——October meeting. Report. 556
Chicago women chemists' meeting. 776
Chilean mills, Discussion of advantages. Lennox. (N.) 458
Chimney, Anaconda Copper Mining Co. *609
China, Chemical industry in. 785
China, Foreign trade for 1918. 529
China wood oil and rosin paints. Toch. 767
Chino Copper Co., Report. 167

CHLORINE:

——Allen-Moore electrolytic chlorine cell in paper mill. Mitchell. *370
——Chlorine plant at Edgewood Arsenal. Green. *17
——Electrolytic caustic soda-chlorine cells. Horine. *69
——Electrolytic chlorine cells, Observations regarding. Wheeler. 436
——Electrolytic chlorine cells, Removing impurities. Moore. (P.) 403
——Nelson electrolytic chlorine cell. Carrier. *133
Chloroform from carbon tetrachloride. Dow and Quayle. (P.) 403
Chromon resists molten brass and bronze. Kinnison. 608
Civil service examinations. 72, 192, 228, 428
Cleveland open cup method for flash points. 248

COAL:

——Ash, Fusibility of. Blakeley 60
——Coking Illinois coal in Koppers type oven. McBride and Selvig. *122
——Crushed. Burning. Schultz. (P.) *211
——Low-temperature carbonization in British Columbia. 117
Cohune Nut Industry. 15

COKE:

——Coking Illinois coal in Koppers type oven. McBride and Selvig *122
——Experimental-retort tests of Orient coal. McBride and Brumbaugh. *171

COKE OVENS:

——By-product, Operations. 689
——Cementing jamb joints in. *153
——Koppers, Installation at Providence Gas Co. *149
Collodion plan *499
Colorado Fuel & Iron Co., open hearth practice 610
Colorado Potash Co. 222
Columbia University fellowships. 63
Combustion chart for gases. Grebel. *641
Compensation, Who are entitled to. Sherlock. 639
Consolidated Coppermines Co., Metallurgical plan. 512
Consolidated Mining & Smelting Co. of Canada, Report. 167
Constantan. Bash. (N.) 554
Construction and operation; 55, 110, 161, 217, 267, 410, 507, 539, 586, 651, 700, 748, 796
Consular service, Opportunities for retired technical men in. 455

COPPER:

——In furnace slags. Maier and van Arsdale. (S.) *46
—— Correction. 61
——Metallurgical plan for Consolidated Coppermines Co. 512
——Separation of matte from slag. Lloyd. (P.) 403
——Substitutes for, In Germany. *740
——Tuyere puncher for copper converter. Arch. (P.) 48
——Waste, Treating. Cito (B.P.) 404
Copper alloys, Copper-aluminum (91-9) alloy. Krynitzky. *770
Copper camps, Labor troubles in. 276
Copper ores, Sulphatization and flotation. Christensen. (P.) 642
Copper sulphate. Electrical conductivity, etc., of saturated solutions in presence of sulphuric acid. Goodwin and Horsch. *181
Corrosion: (see Metal protection.)
Coslett process. 787
Cost accounting in commercial laboratories. Caswell. (N.) 288
Cotton consumption, 1918-19. 666
Cotton, World's production. 627
Cottonseed oil industry. Wesson. 661

COTTRELL PRECIPITATOR:

——For silver refinery fumes. Smith and Heimrod. *360
——Use in English blast-furnaces. 724
Covalency, Theory of. 77
Crucibles, Graphite-magnesia-clay. Tone. (P.) 48
Crusher, Gyratory, Sixty-inch. 207
Crushing practice at Ajo, Ariz. Dumoulin. (N.) 459
Crystalline form, Effect of surface tension on. Desch *773
Cumar plant, Barrett Co. 494
Cumar synthetic resin. 456
Current Market Reports; 50, 105, 156, 212, 262, 405, 441, 473, 503, 535, 582, 590, 593, 596, 599, 602, 647, 696, 744, 792

CYANAMIDE:

——As fertilizer in France. 612
——Cost of manufacture at U. S. Nitrate Plant No. 2. 67
Cymene, Dyes from. Andrews (P.) 743

D

DETINNING PROCESSES:

——Chlorine. Zacharias. (P.) 49
——Chlorine. Wilcox. (P.) 255
——Electrolytic. Lodge, et al. (B. P.) 103
Dichromates, Alkali. (B. P.) 404
Dicyandiamidine perchlorate in explosives. Rintoul, et al. (B. P.) 742
Di-ethylketone from propionic acid. Sedgwick and Lambert. (B. P.) 742
Digester, Paper pulp, Lining for 760
Dilatometer, Stretched wire. Gray. *667
Dill and Collins Co., Chlorine bleach dept. Mitchell. *370
Dimethyl sulphate, Mfr. Haworth and Irvine. (B.P.) 103, 579
Disintegrating metals. Hall. (P.) 210

DISTILLATION:

——Benzene, Continuous. Baril. (S.) *693
——Continuous distillation of sludge acid. Hechenbleikner and Gilchrist. (P.) *212
——Of coal tar light oils, etc. Barrett Co. *493
——Of petroleum, Modern practice. *488
Dolomite, Burning. 491
Dow Chemical Co., Development of processes at. Dow. 452
Dry cells: (See Batteries, Primary)
Drying, Factors in drying operations. Alliott. *620
Duralumin, Properties, etc. Merica and Jeffries. (N.) *551

DYES:

——Alcohol in dye industry. Cretcher. (N.) 558
——American dye industry. 65
——British establish Central Importing Agency. 170
——Color variation in crystals. Wherry. (N.) 287
——From cymene, aminocymene and spruce turpentine. Andrews. (P.) 743
——House passes Longworth dye bill. 614
——Review of the dye situation. Matthews. (N.) 286
Eastman Kodak Co., Mfr. of organic chemicals at. Clarke. 777
——Synthetic organic chemicals produced at. Mees. (N.) 288
Edgewood Arsenal, Chlorine-caustic soda plant at. Green. *17

E

EDITORIALS:

——American chemists in peace session. 269
——Announcement of weekly publication 413
——An announcement to our readers. 541
——Applied economics 749
——Approaching normal publication dates 653
——Are we engineers or are we economists? 58
——Automatic control devices in the chemical industries 3
——Books beat bullets 703
——Andrew Carnegie, steel manufacturer 163
——Chemical and physical constants. 703
——Chemists and labor unions 477
——Chicago—Host to science and engineering 269
——Control of large corporations and of large labor unions 478
——Co-operation between industry and university 1
——Co-operative industrial research laboratories. 272
——The cost-plus contract in future construction work 607

*Illustrated; (P.), (B. P.), (Aust. P.), (Can. P.)—United States, British, Australian and Canadian patents, respectively; (S.)—Synopsis; (N.)—Papers read at society meetings but not printed in full.

EDITORIALS—*Continued*:
——The dawn of peace 1
——Declaration of American policy toward German dyes 114
——The determination of steel prices 59
——Does American potash need a fixed price? 220
——Essential qualifications for commercial agents in Latin-America 113
——European opinion regarding Mexico 164
——Every engineer a counter propagandist. 701
——The fallacy of class distinction in chemistry. 270
——Fifth National Exposition of Chemical Industries 219
——Fifth National Exposition of Chemical Industries 415
——The Forest Products Laboratory, valued servant of the industries 750
——Fuel oil combustion and conflagration. 750
——The future of commodity and property values 751
——Herbert C. Hoover—American citizen. 414
——Imagination and success 655
——Importance of data on small volume changes. 653
——Industrial Conference splits on collective bargaining. 542
——Is molybdenum a metallurgical mystery? 1
——Labor research and scientific control 164
——Labor-saving machinery in iron and steel industry 606
——Lessons from the Industrial Conference. 510
——Lest we forget our soldier chemists 605
——Mechanical charging of lead blast-furnaces 271
——More about American dyes 653
——More power to the Bureau of Mines 415
——Need of a firm policy in Mexico 2
——New chemical laboratory for Cornell University 113
——A new function for our engineers abroad 510
——A new philosophy of chemistry and matter 57
——Oil shales and the merchant marine 702
——Optimists in spite of appearances 749
——Out of the woods 701
——The path of sanity 413
——A phase of the flotation decision 59
——The potentiality of a glucinum industry 270
——The President's Industrial Conference 477
——The President's new Labor Conference 605
——Pyrometers for brass and bronze makers 114
——Recognizing the importance of non-metallic minerals 271
——Reconstruction still lags 702
——Restoration of foreign exchange 543
——A rose by any other name 2
——A scientific union from Chicago's City Hall 542
——A Scotch professor and the control of research 509
——The season of tariff hearings 57
——A second double issue 605
——Shabby treatment of patent examiners 219
——Shape of metallic crystalline grains 750
——The shoe on the other foot 115
——The sorry plight of our educational institutions 445
——Stability of prices and employment 3
——Steel production during the war 115
——Steel prices and service 655
——The steel strike an object lesson 415
——A suggestive theory on sonims 541
——A thought on labor's goal 654
——A thought on the general unrest 163
——A truce in labor demands 221
——Union of thinkers and workers 606
——An unscrambled organization 509
——Views on potash: a point of time 445
——War Department deserts Chemical Warfare Service. 165
——Welfare work or manpower engineering 446
——The White House Conference on Labor 273

EDUCATION:

——Americanization work in Newark, N. J. 375
——Chemical Technology for college students. Grossman. 4
——Course in physical measurements for chemistry students. 503
——Engineering course for college professors. 423
——University and college endowment. Little. 658
Effervescing steel. Hibbard. (N.) 459
Electrical conductors, Cu, Al, Zn and Fe as *740
Electrical show, Chicago *708
Electric Furnace Association:
——Chicago meeting. Announcement 277
—— Report 549

ELECTRIC FURNACE:

——General:
—— Bureau of Mines electric furnace laboratory. Grier *574
—— Classification of. 674
—— Design of. Gosrow. 235
—— Criticism. Bardwell. 479
—— Reply. Gosrow. 479
—— Improving mechanical operation of. Moore. (P.) 49
—— Melting non-ferrous metals and alloys in. Collins *673
—— Metallurgical. Commercial testing of. St. John *377

ELECTRIC FURNACE—*Continued*:
—— Square deal for the electric furnace. Weidenthal 779
—— Symposium at A. I. C. E. meeting. 6
——Various designs:
—— Arc type. Rennerfelt. (P.) *580
—— Booth rotating. Booth *636
—— Brass furnaces. Gillett. (N.) 6
—— Correction. 116
—— Brass furnaces, Resistance type. Baily. (N.) 11
—— Brass furnace, Rocking type. St. John. (N.) 13
—— Compound resistor type. Colby and Thornton. (P.) *210
—— Electrically heated soaking pits in steel industry. Baily *624
—— For experimental work. FitzGerald and Moyer *769
—— Induction furnace, Northrup-Ajax. Northrup *258
—— Radiant resistor furnace for zinc. FitzGerald *737
—— Radiant resistor. FitzGerald. (N.) 522
—— Rennerfelt. (P.) *210
—— Rennerfelt steel furnace, Working results. Frick, et al. (S.) 101
—— Resistance. Weidenthal. (P.) 48
—— Resistance muffle. Fitzpatrick and Stevens. (P.) *580
—— Silicomanganese furnace *752
—— Tilting device for. Gray (P.) 439
—— Vacuum furnace, G. E. Co. *708
—— Vertical-cylindrical. For heat-treating and shrinking. Clark *205
Electric precipitator: (see Cottrell)
Electric Storage Battery Co. plant 490
Electrochemical industry: (See Chemical Industry)
Electrochemical production of organic compounds. Thatcher. 663

ELECTRODEPOSITION:

——Lead plating from fluoborate solutions. Blum, et al. (N.) 526
——Of copper from solutions containing ferric sulphate. Greenawalt. (P.) 643
——Of various metals. Leech and Slater. (B. P.) 472
——Structure of electrodeposited metals. Blum. (N.) 526
——Tungsten wires by. Keyes. (P.) 48

ELECTRODES:

——British. (S.) *641
——Compound. Shoeld. (P.) 439
——For chlorine cells. Marsh. (P.) *210
——Silicon iron. Smith. (P.) 256
Electrolytic chlorine cells: (see under Chlorine.)
Endowment, University and college. Little. 658
Engineering Council on U. S. maps. 431
Engineering course for college professors 423
Engineers, Registration of, In Iowa 722
England, Potash recovery from blast-furnace gases in. Hibbert. 723
English chemical industry, Status of labor in. Marshall. 16
Ethyl alcohol: (see Alcohol.)
Ethylene dichloride. Curme. (P.) 743
Ethylene from ethyl alcohol. 557
Ethylene, Purification of. Curme. (P.) 743
Evaporator, Rapid circulation *706
Expansion, Thermal, Measurement by stretched wire dilatometer. Gray. *667
Explosion of chemicals: (see Legal notes.)

EXPLOSIVES:

——Modern commercial. Hill. (N.) 288
——Nitrocellulose-nitroglycerine. Rintoul, et al. (B.P.) 695
——Perchlorate. Rintoul, et al. (B.P.) 742
—— Perchlorate Safety Explosives, Ltd. (B.P.) 742
—— Pronk and Bowen. (B.P.) 742
——Primers, Trinitro-nitranilid and sulpho cyanates for. Buell. (P.) 440
——Research and testing. Tibbals. (N.) 556
Explosive plants, English, Organization of. Townsend. (N.) 534

EXPORT STATISTICS:

——Germany:
—— Potash and potassium salts. 1913. 726
——Peru:
—— Tungsten ores, 1913-17. 789
—— To New York, 1918 789
——United States:
—— Caustic soda, May, 1919 200
—— June, 1919 227
—— Glycerine, Apr., 1919 15
—— June, 1919 227
—— Lead, May, 1919 200
—— Mining machinery, May, 1919 200
—— Platinum, May, 1919 200
—— Soda ash, May, 1919. 200
—— June, 1919. 227
—— Sugar, 1915-1918 363
—— Tinplate, terne plate and taggers tin. Apr., 1919 15
—— Tungsten and ferrotungsten. Apr., 1919 15
—— May, 1919 200
—— June, 1919 369
—— Zinc, May, 1919 200
Export Trade:
——Selling in Foreign Markets. 438
Export Trade Act. 228
Exposition of Chemical Industries: (see Chemical Industry, Exposition of.)
Exposure tests of sheeting material. Hoyt. *142

F

Fats, Recovering from trade waste. De Baeve (Aust. P.) 790
Ferrochromium, By aluminothermic reaction. Turner. (B.P.) 472
Ferromagnesite, Mfr. at Northwest Magnesite Co. *480
Ferromanganese, Adding in ladle at C. F. & I. Co. 610
——Potassium permanganate from. Thompson. 680
Filtration, Industrial filtration. Faber. (N.) 614
——Bryden. (N.) 705
Fertilizers, German production, 1913-1919. 431
Fiber, Anhinga, As cotton substitute. 785
Flakes: (see Iron and Steel. Metallography.)
Flash points of gasoline-kerosense mixtures. Robson and Withrow. *244
Flooring composition, Magnesite for. 117

FLOTATION:

——Alpha naphthylamine-xylidine mixture for 418
—— Correction. 565
——Monopoly in Spain. 178
——Paper mills use. 529
Foam cells, Structure of 773
Food dehydration. Falk 709
Foerderer, Robert H., Leather factory. *489
Forehearth for reducing slag losses of metals and matte. Lloyd. (P.) 403
Forging: (see Iron and Steel, Mechanical work.)
Forest Products Laboratory. Jones. *757
Foster closed cup method for flash points. 249
Fractures, Mechanism of. deFreminville. (N.) 618
France, Consumption of hydro-electric power and raw materials in chemical and metallurgical industries. (S.) 399
——Foreign trade, Jan.-June, 1919 363
——Fuel oil question in 709

FUEL:

——Fuel problem in Europe. Engel. (N.) 533
——Graphical representation of composition and properties. Schreber. (S.) *578
——Tar for open-hearth furnaces. 610
Fuel oil, Tentative regulations for storage and use. 781
Fuller's earth, Preparation of. Phalen 469
Furnaces; (see Iron and Steel, Furnaces; Electric furnaces, Blast furnaces, etc.)

G

GAS AND GASES:

——Combustion chart. Grebel. (S.) *641
——Improved Orsat apparatus for analysis. Jones and Neumeister *734
——In Steel, Determination of. Cain. (N.) 459
——Laws, Alignment chart for. Wikoff. 195
——Manufacturing plant of Providence Gas Co. Russell. *34, *88, *147
——Poison, Production at German dye plants. 224
——Producer, Ammonia in. Ovitz. 253
——Producer, Cost of. 243
Gas analysis by interferometer *393
Gas exhausters, Rotary, Pressure governor for *99
Gas flow, Resistance of tower packing to. Zeisberg 765
Gas mantle manufacture *497
Gas masks in the industries. Fieldner. (N.) 287
Gas producers, Operation of. McClimon *633
——Providence Gas Co. installation *91
Gasoline-kerosene mixtures, Flash and burning points of. Robson and Withrow *244
General Electric Co. heat-treating furnace *205
General Electric method for m. p. of asphalt 82
Generators, Direct current, New type *644
German dyes and chemicals, Peace treaty provisions 121
German dye plants, Present condition. Sill. (N.) 286
German dye plants, War-time activities of 224
German-owned chemical plants sold 121
German production of fertilizers, 1913-1919 431
German scientific books, Importation of 24
Germany, Brass foundry methods in 754
——Substitute metals in *740
——War-time ferrous metallurgy in. (S.) 789
Gibbs, Willard, Medal presented to Dr. Wm. A. Noyes *448

GLASS:

——Chemical glassware mfrs. fear Japanese 199
——Optical, Manufacture of. Hostetter. (N.) 468
——Optical, Thermal expansion of 670
——Optical, Twenty-three types of. Montgomery. (N.) *467
——Scientific research in glass industry. Washburn. (N.) 463
——Raw materials, Buy on analysis. Silverman. (N.) 468
——Tariff bill on glassware, etc. 120
——Use of manganese ore in 198
Glass molds, Alloy for. Milliken. (P.) 210

*Illustrated: (P.), (B. P.), (Aust. P.), (Can. P.)—United States, British, Australian and Canadian patents, respectively; (S.)—Synopsis; (N.)—Papers read at society meetings but not printed in full.

INDEX

Glauber's salt in Siberian lakes 771
Glucinum. Negru 353, 417
——Criticism. Parsons 544
—— Reply. Negru 544
Glue, Research work at Forest Products Laboratory 760
——Tensile strength of. Hopp. (N.) 292
——Water-resistant. Browne *136

GOLD AND SILVER: (See also, Silver)

——Australian production 473
——Decrease in world's production 170
——Volatilization of gold. Rose. (S.) 101

GOVERNMENT:

——Purchases during war, Record of 739
——Surplus supplies, Disposal of:
—— Lead 4
—— Phenol 481
—— Trinitrotoluene 577
——To make armor and heavy forgings 228
Graphite, Tariff bill, House considers 640
Griscom-Russell Co., pipe line strainer *207
Groch "Save-All" for paper pulp mills 529
Gun metal. Karr. (N.) *555
Gyratory crusher, Sixty-inch 207

H

Halberg-Beth bag system of dust collection 723
Hardwood: (see Wood.)
Havana, American Chamber of Commerce for 334
Heatmeter, New compensated. Frey *259
——Criticism. Taylor 416
Heat treatment: (see also Iron and Steel, Heat treatment.)
Helium, Government plants 276
Hoover, Herbert C., Address at A. I. M. E. dinner 419
Hopkins, Dr. Cyril G., Obituary 581
Hough nitrator, New uses for 456
Hunt, Robert W., Award 753
Hydrocarbon cement. Barrie and Chadwick. (Aust. P.) 791
Hydrocarbons, Acyclic and saturated cyclic hydrocarbons. Chavanne and Simon. (S.) 403
——Cracking. Nilson and Petrol Patents, Ltd. (B.P.) 742

Hydro-electric power:

——Resources in U. S., Map 343
——Systems in North Central States. Jones *342
—— Map 341
Hydrogen, Ozone form of. Wendt. (S.) 790
——Penetration of iron by. Fuller. (N.) 521
Hydrogen peroxide, "Albone" 456
Hydrometers, Types, moduli and calculations on slide rule. Savage *395
Hytempite, Cementing jamb joints with *153

I

Ignition of D. & L. sinter cake. Adams. (P.) 48
Illinois: (See also Chicago district.)
——Chemical industries of. Thomson *315
——Hydro-electric and steam power plants 345
Illinois, University of, Mfr. of organic chemicals at 777
Import restrictions, Tin, Correction 24

IMPORT STATISTICS:

——Canada:
—— Principal articles, 1918-19 707
——England:
—— Potassium compounds. 1913 726
——United States:
—— Glycerine. Apr. 1919 15
—— June, 1919 227
—— Iridium, etc., May, 1919 200
—— Lead and ores, May, 1919 200
—— Magnesite, calcined. 1912-17 120
—— Platinum, May, 1919 200
—— Tin bars, blocks, pigs, etc. Apr. 1919 15
—— Tin ore. Apr. 1919 15
—— Tungsten ores. Apr. 1919 15
—— May, 1919 200
—— June, 1919 369
—— Zinc and ores, May, 1919 200

Indiana:

——Chemical industries. Anderegg *324
——Hydro-electric and steam power plants 347
——Natural and industrial resources of *320
——Raw material resources. Logan *320
—— Map 322
Industrial Conference, Report of 481, 514
Industrial magazines and labor conditions. Cleland 682
Industrial news..55, 110, 161, 217, 267, 410, 507, 539, 586, 651, 700, 748, 796
Industrial notes...56, 111, 162, 218, 411, 508, 540, 651, 700 796
Industrial resources of France, Germany, Great Britain, United States and world for 1913. (S.) 400
Infections, Liability for. Sherlock 252
Ingots for locomotive tires and rolled wheels. Fry. (N.) 547
Insurance for chemical plants. An innovation in 754

Interallied Chemical Confederation, London meeting 234
Interferometer, Gas analysis by. Edwards 560
Interferometer, Industrial analysis of gas mixtures by. Pouchon *392
International Exposition of Mining Industries 121, 428
International Research Council monographs 776
International Union of Pure and Applied Chemistry 234
——Incorporation with International Research Council 424
Iowa, Registration of engineers in 722
Iron, Penetration by hydrogen. Fuller. (N.) 521
——Use as electrical conductor in Germany *740
Iron and Steel Institute, Jubilee meeting *40
Iron and Steel Market....50, 105, 157, 218, 263, 406, 441, 474, 504, 536, 582, 590, 593, 596, 599, 602, 647, 696, 744, 792

IRON AND STEEL:

——Analysis:
—— Determination of gases in steel. Cain. (N.) 459
——Corrosion and protective coatings: (See Metal protection.)
——Furnaces:
—— Blast-furnace uptakes. Kennedy. (P.) 49
—— Electric furnace, Square deal for. Weidenthal 779
—— Open hearth:
—— Constitution of acid hearth. Whitey and Hallimond. (N.) 44
—— Furnace construction. Howe. (N.) 546
—— Refractories for. Howe. (N.) 459
—— Rennerfelt electric steel furnace, Working results. Frick et al. (S.) 101
——Heat treatment:
—— Double heat treatment for steel castings. Hall, Nissen and Taylor. (N.) 461
—— Electrically heated soaking pits in the steel industry. Baily *624
—— Hardener, Automatic. Fay. (P.) 48
—— Heat-treating furnace, Automatic. Mitchell. (S.) 101
—— Heat treatment of 155-mm. high explosive shell. Merten *687
—— Speed of Quenching. Portevin. (N.) 41
—— Tempering machine for tools, Automatic. Stee and Kolhede. (P.) 403
—— Vertical-Cylindrical electric furnaces for heat-treating and shrinking. Clark *205
——Ingots:
—— For locomotive tires and rolled wheels. Fry. (N.) 547
——Mechanical work:
—— Allis-Chalmers forge shop *576
—— Electrification of reversing steel mills. Sykes. (N.) 546
—— Fusion welds. Miller *729
—— Rolling mill practice, Trend of. Hunt. (N.) 460
—— Welding metals to iron and steel. Pittevil. (B.P.) 103
——Metallography:
—— Defects in fusion welds in relation to transverse rail fissures and flakes. Miller *729
—— Effect of time on physical properties of medium carbon steel. Reinhardt and Cuttler. (N.) 460
—— Fibrous structure in high carbon steel. Lorenz 208
—— Flakes in alloy steel. Thum 145
—— Flakes in Ni steel gun forgings. Hayward 116
—— Flakes, Transverse rail fissures and defects in fusion welds. Miller *729
—— Fractures, Mechanism of. de Freminville. (N.) 613
—— Graphitization. Tawara and Asohara. (N.) 41
—— Impact strength. Langenberg. (N.) 461
—— Liquidus of Fe-C Diagram. Cesáro. (N.) 40
—— Macro-Etching and Printing. Humfrey. (N.) 40
—— Non-Allotropy of A_3. Honda. (N.) 40
—— Photographing steel forgings at low magnifications. Foley *140
—— X-Ray examination of metals. Ruder. (N.) 546
——Processes:
—— Bessemer, Acid:
—— Metallurgical calculations. Bagley. (N.) 45
—— Manganese oxidation in. McCaffery. (S.) 155
—— Overcoming spitting in. McCaffery. (S.) 155
—— Bessemer, Basic:
—— Metallurgical calculations. Bagley. (N.) 45
—— Cast steel, Double heat treatment for. Hall, Nissen and Taylor. (N.) 461
—— Open hearth, Acid:
—— Constitution of slag. Whitely and Hallimond. (N.) 44
—— Deoxidation. Yaneske. (N.) 43
—— Lime as slag constituent. Yaneske. (N.) 43
—— Metallurgical calculations, Bagley. (N.) 45
—— Open hearth, Basic:
—— Metallurgical calculation. Bagley. (N.) 45
—— Open hearth process. Howe. (N.) 546

IRON AND STEEL—*Continued:*
—— Thomas:
—— Metallurgical calculations. Bagley. (N.) 45
——Special steels:
—— Aircraft steels. Sauveur. (N.) 460
—— Alloy steel, Flakes in. Thum 145
—— Chromium steel. Turner. (B.P.) 472
—— Effervescing steel. Hibbard. (N.) 459
—— High-speed tool steel, Mfr. by aluminothermic reaction. (B.P.) 471
—— High-speed steel, Mfr. of. McKenna. (N.) 530
—— Manganese steel, Mfr. Hadfield. (P.) 403
—— Molybdenum steel, Production in U. S. 153
—— Nickel steel gun forgings, Flakes in. Hayward 116
—— Rifle-barrel steel. Bellis and Butterworth. (N.) 460
—— Stainless steel. (S.) 498
—— Tool steel:
—— Manufacture and working. Andrew & Green. (N.) 42
—— Microscopy and Mechanical Properties. Arnold. (N.) 43
Iron Ore:
——Agglomeration of clay-bearing and high-sulphur ores. Swart and Klugh. (P.) 49
——Briquetting. Lammerhirt. (P.) 694
——Magnetic susceptibilities of. Louis. (S.) 102

J

Jackling Porphyries, Reports 166
Japan, Refractories industry in. Kurahashi *185
——Steel industry in 144
——Tin-plate manufacture in 645
Japanese chemical industries, Progress in. Annebault. (S.) 208
Japanese decision on trade marks 778
Japanese porcelains. Kitamura 183
Jordan Scientific Society 194

K

Kelp, Growth of. Turrentine 202
Kerosene-gasoline mixtures, Flash and burning points of. Robson and Withrow *244
Kingsport Wood Reduction Co. plant *193
Kramer and Sarnow method for m. p. of asphalt 82

L

LABORATORIES:

——Beckman & Linden Eng. Corp., San Francisco 117
——Bureau of Mines electric furnace laboratory. Grier *574
——Commercial, cost accounting in. Caswell (N.) 288
——Electrometallurgical research laboratory in San Francisco 117
——Forest Products Laboratory. Jones *757
——Pittsburgh Station, Bureau of Mines. Thum *432
—— Dedication *545
Laboratory process, How long to develop into dividend? Dow 452
Labor conditions and industrial magazines. Cleland 682
Laboring man and the mails 610
Labor, Status of, In English chemical industry. Marshall 16
Labor troubles in copper camps 276
Lactic acid from sawdust. Richter (P.) 49
Landreth direct oxidation process of sewage purification 772
Langmuir postulates. Hendrick *78
Laughlin, James, Jr. Obituary 647
Leaching, Apparatus for sulphurous acid. Leaver. (P.) *404
Lead, Electrolytic. Jourieff. (B.P.) 472
Lead blast-furnace:
——Effect of blast-roasting on design of. Mallette 67
Lead burning with water-gas and oxygen 490
Lead chromate pigments. Morris. (B.P.) 404
Lead furnace ventilating hoods 118
Lead oxides, Red lead, Analysis of. Ericson 61
Lead salts, Electrolytic method for white lead, etc. Harrington. (P.) *255
Leather, From sharks and porpoises 580
——Mfr. at plant of Robert H. Foerderer *489
——Treating with oil. Hawkins. (Can.P.) 791
Legal Notes:
——Explosion of chemicals:
—— I. Common law liability. Sherlock 83
—— II. Workmen's compensation acts. Sherlock 131
——Liability for infections. Sherlock 252
——Patent rights and remedies. Sherlock 786
——Who are entitled to compensation. Sherlock 639
Lignite Utilization Board of Canada 45
Lime, Mfr. at Cedar Hollow plant of Charles Warner Co. *491
Lime-barium treatment for boiler feed water. Mehring *629
Lime kilns, Rotary vs. vertical *492
Lodge Fume Co. 724
Love, Dr. E. G. Obituary *440
Luckie, Robert R. Obituary 647

*Illustrated; (P.), (B. P.), (Aust. P.), (Can. P.)—United States, British, Australian and Canadian patents, respectively; (S.)—Synopsis; (N.)—Papers read at society meetings but not printed in full.

M

McFarland, Charles N. Obituary 647
McKelvy, E. C. Obituary 744

MAGNESITE:

——Austrian industry 671
——For flooring composition 117
——Plant of Northwest Magnesite Co. *480
——Refractories from American 704
——Status of domestic magnesite industry 119
——Tariff bill, House passes 565
Magnesium, From magnesium oxide. Seward. (P.) 439
Maltose conversions, Determination of. Coombs 398
Manganese borate, Manufacture of 199
Manganese chloride, Use of 199
Manganese dioxide ore, Uses of. Phalen 196
Manganese linoleate, Manufacture of 199
Manganese oxalate, Manufacture of 199
Manganese persulphate, Manufacture of 199
Manganese resinate, Manufacture of 199
Manganese sulphate, Manufacture of 199
Manganin. Bash. (N.) 554
Manganin, Study of. Hunter and Bacon. (N.) 520
Manufacturers' catalogs, 111, 268, 508, 540, 652
Manufactures, Census of 714
Maps, Engineering Council on 431
Maritime Chemists' Association 191
Markets, Non-Ferrous, Iron, Steel and Chemical, 50, 105, 156, 212, 262, 405, 441, 473, 503, 535, 582, 590, 593, 596, 599, 602, 647, 696, 744, 792
Marting, H. A. Obituary 647
Massachusetts Institute of Technology, Alumni vocations 658
Mathematical journal, New German 511
Matte, Separation from slag. Lloyd. (P.) 403
Meetings and Events, Coming 56, 112, 162, 218, 268, 411, 507, 540, 700, 748, 796
Melting, Preventing oxidation of metals during. Bristol. (P.) 642
Merchant marine tonnage, World's 423

MERCURY:

——Production in U. S. First quarter. 1919 64
——Recovery from ores. Gould. (P.) 694
——Spanish production and exportation 448
Metallography, Contributions to l'art nouveau *657
Metallography of steel: (See Iron and Steel, Metallography.)
Metallurgical control, Graphic. Merry. (N.) 458
Metallurgical furnaces, Calculations for oil-fired furnaces. Bregman. (S.) 402
Metallurgy, Non-ferrous, In Chicago district. Pulsifer *310
Metallurgy, War-time ferrous metallurgy in Germany. (S.) 789
Metal protection, Adherent rust as accelerator in corrosion of iron and steel. Richardson. (N.) 293
——Exposure tests on Cu-steel, pure Fe, bessemer and o.-h. sheets. Hoyt 142
——Phosphatic coatings for rust proofing iron and steel. Eckelmann *787
Metals, Atomic structure in solid solution *566
——Determining thermal conductivity of. Wilkes *241
——Non-ferrous, Melting in electric furnace. Collins *673
——Prevention of oxidation during melting. Bristol. (P.) 642
——World's production 527
Methyl alcohol: see Alcohol.

MICHIGAN:

——Chemical industries. Badger 330
——Hydro-electric and steam power plants 345
——Mineral resources. Smith *326
——Natural and industrial resources *326
Microscope in war 169
Mineral leasing bill 721
Minerals, Non-metallic, Need for research. Ladoo *348
Minerals Relief Commission:
——Procedure for consideration of claims 95
——Interpretation of Relief Act 146
——Resumes work on claims 428
——Proposed extension of Relief Act 527

MINING & METALLURGICAL SOCIETY OF AMERICA:

——Gold medal presented to Charles E. Schneider 614
Minnesota State-owned iron mines 340
Mitchell electric vibrating screen *644
Molybdenum, From sulphide ores by chloridizing. Forland. (P.) 256
——From wulfenite. Bonardi 364
Monazite sand, Treatment of, At Welsbach Co. *500
Moore, Dr. R. B., appointed chief chemist of Bureau of Mines *547
Motors, Direct current, New type *644

N

Naphthalene-shellac plastic. McCoy. (P.) 694
Naphthalene plant, Barrett Co. *495
National Conference of Business Paper Editors 659

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES:
(See Chemical Industry, Exposition of.)

NATIONAL RESEARCH COUNCIL:

——Division of Industrial Research. Howe. (N.) 288

NATIONAL SAFETY COUNCIL:

——Eighth Annual Safety Congress. Announcement 277
—— Program 426
Natural and industrial resources of France, Germany, Great Britain, United States and world for 1913. Agricola. (S.) 400
Nelson electrolytic chlorine cell, Carrier *133
Nevada Consolidated Copper Co., Report 167
Newark, Americanization work in 375

NEW JERSEY CHEMICAL SOCIETY:

——December meeting. Report 705

NEW YORK SECTION, A. C. S.:

——October meeting. Report 557
——November meeting. Cellulose 708
——December meeting. Food dehydration 709
Nickel, Physical properties of. Thompson. (N.) 550
Nitric acid, Cost of manufacture at U. S. Nitrate Plant No. 2 66
Nitrator, Hough, New uses for 456
Nitrogen, Allotropic. Leffmann. (S.) 693
Nitrogen fixation, In Europe during the war. Joyes 612
——Manufacturing costs at Muscle Shoals 66
Nitrogen oxides from ammonia. Maxted and Ridsdale. (B. P.) 694
Nitrous oxide, Purification. Warner. (P.) 694
Nitro, W. Va., for sale 399
——Sold 681
Nomenclature. Sulphuric acid. Sullivan 511
Non-Ferrous metal market 50, 105, 156, 212, 262, 405, 441, 473, 503, 535, 582, 590, 593, 596, 599, 602, 647, 696, 744, 792

NORTH CENTRAL STATES:

——Hydro-electric systems in. Jones *342
—— Map 341
——Natural and industrial resources of 309
——Resource map of 309
Northwest Magnesite Co. *480
Noyes, Dr. Wm. A., Willard Gibbs medalist *448

O

Oil pastes, Preparation without drying. Fletcher. (Aust. P.) 790
Oil shale industry (B. of M. paper) 178
Oil shale retort. Hoover. (P.) *256
Oil shales. Simpson 177
——Bill providing for research on 428

OILS:

——China wood, Use with rosin in paints. Toch 767
——Cottonseed oil industry. Wesson 661
——Fuel, Tentative regulations for storage and use 781
——Recovering from trade waste. De Baeve. (Aust. P.) 790
Open hearth process (see Iron and Steel, Processes)
Ores, Process for treating. Coolbaugh 642
Organic chemicals for research. Clarke 777
Organic compounds, Electrochemical production of. Thatcher 527, 663
Orsat apparatus, Improved. Jones and Neumeister *734
"Over mercury" method for m. p. of asphalt 81
Oxalic acid from paper mill waste liquors. Reed. (P.) 440
Oxidation of metals during melting, Preventing, Bristol. (P.) 642

P

Packaging Machinery, Manufacturers of 5
Packing Containers, Tests at Forest Products Laboratory 762
Packing, Tower, Resistance to gas flow. Zeisberg *765
Paint for tropical climates. Major. (Aust. P.) 791
——Rosin in. Toch 767
——Manganese salts used as driers 198
——Manufacture of. Holton. (N.) 705
Paper, Parchmentized. Dagnall. (B. P.) 579
——Washing unbleached soda pulp. Griffin. (N.) 528
Paper pulp digester, Lining for experimental 760
Paper pulp mold. Kress. (N.) 529
Paper pulp research at Forest Products Laboratory 760
Paper mill, Electrolytic bleach by Allen-Moore cell. Mitchell *370
Paper mill waste liquor, Oxalic acid from. Reed. (P.) 440
Parkerizing. Eckelmann *787
Parsons, Dr. Chas. L., retires as chief chemist, Bureau of Mines *547
Patent Office bills 479
——Congressional hearing on 63
Patent renewal fees, Symposium on. (N.) 290
Patent rights and remedies. Sherlock 786
Patents, Increased cost of printed copies 613
——Whole U. S. patent system in danger 755
Patents, Recent chemical and metallurgical 48, 103, 209, 255, 403, 439, 471, 579, 642, 694, 742, 790
Peru, Tungsten situation in 739
Petroleum, Refining at Atlantic Refinery Co. *488
——Research work to be undertaken 486
Petroleum industry, Need of research in. Manning 727
Phenolaldehyde condensation products. Dior. (B. P.) 472
Phenol plant, Barrett Co. *495
Phosphatic coatings for rust proofing iron and steel. Eckelmann *787
Physical measurements for chemistry students *503
Picric acid. Badier and Holliday. (B. P.) 694
——Graesser and Titherley. (B. P.) 695
Pipe line strainer *207
Pittsburgh Station, Bureau of Mines. Thum *432
——Dedication *545
Plastic composition, Shellac-naphthalene. McCoy. (P.) 694
Platinum metals, Recovery from copper slimes. Ferguson. (P.) 642
Porcelain, Japanese, From chemical viewpoint 183
Porphyry ore, Proposed treatment 512

POTASH:

——Does American potash need a fixed price? Brown 447
——From blast-furnace gases in England. Hibbert 723
——From feldspar and leucite by electrolysis at Colorado Potash Co. 222
——From iron blast-furnaces. Cutlett. (P.) 404
——From silicates. Robertson. (Can. P.) 791
——From wood ashes. Bateman *615
——German, Importation allowed 170
——Searles Lake, Borax in 427
——Situation 418
Potassium permanganate from ferromanganese by electrolysis. Thompson 680
Potassium permanganate, Manufacturing and uses of 199
Potassium salts, Refined, Production in 1918 581
Potentials, Algebraic sign of. Committee report 520
Postal-zone law, Dangers of. Capper 487
——Effect on laboring man 610
——Menace of. Mondell 469
——Vicious. Capper 639
Prices during the war, History of 81
Prices of chemicals during war. Breithut *174
Priestley's home purchased 705

PRODUCTION STATISTICS:

——Australia:
—— Gold, Jan.-June, 1919 473
——Belgium:
—— Coal, 1913-1918 154
—— Coke, 1913-1918 154
—— Fuel briquets, 1913-1917 155
—— Iron and steel, 1913-1916 155
—— Lead, 1913-1917 155
—— Zinc, 1913-1917 155
—— 1913-1918 571
——California:
—— Magnesite, crude, 1913-1917 120
——Canada:
—— Iron, steel and ferros, 1918 177
——Michigan:
—— Beet sugar, 1914-1917 333
—— Cement, 1913-1917 334
—— Gypsum, 1913-1917 334
—— Salt, 1914-1917 332
——North Central States:
—— Mineral production, 1917 308
——United States:
—— Bromine, 1918 330
—— Calcium chloride, 1918 330
—— Magnesite, crude, 1891-1918 120
—— Mercury. First quarter, 1919 64
—— Metals, non-ferrous. Central States, 1917-18 243
—— Mineral acid. (Gen. Chem. Co.) 68
—— Molybdenum steel 153
—— Potassium salts, Refined, 1918 581
—— Salt, 1918 330
—— Spelter, 1917-1918 33
—— Steel ingots, etc. 115
—— Tungsten products, 1918 200
——World:
—— Gold, 1915 and 1918 (Valuc only) 170
—— Iron and steel, 1916-18 502
Propylene dichloride. Curme. (P) 743
Providence Gas Co. Plant. Russell. *34, *88 *147
Psychological tests of army men *185
Publications, European and African 473
Publications, New 112, 412, 508, 588, 796

PYROMETRY:

——Compensated heatmeter. Frey *259
—— Criticism. Taylor 416
——Recording pyrometry. Wilson 511
——Temperature meaurements in steel furnaces. Burgess. (N) 546
——Thermo-electric pyrometers for plant use. Ashman *85
Pyruvates from starchy material. Fernbach. (B.P.) 695

Q

Quenching liquids, Technical, Cooling properties of. Pilling and Lynch. (N). 461
Quicksilver: (see Mercury)

---

*Illustrated; (P.), (B. P.), (Aust. P.), (Can. P.)—United States, British, Australian and Canadian patents, respectively; (S.)—Synopsis; (N.)—Papers read at society meetings but not printed in full.

R

Radium luminous material, Welsbach Co.. 501
Rail fissures. Miller *729
Ramsay Memorial Fund 45
Ray Consolidated Copper Co., Report 167
Recent Chemical and Metallurgical Patents 48, 103, 209, 255, 403, 439, 471 579, 642, 694, 742, 790
Re-employment problems and methods 225
Refractometric method of gas analysis *392
Refractories, Manufacturers' Association, Work of technical department. Howe. (N.) 289

REFRACTORIES:

——Binder for fire-clay bricks. Kohler. (P.) 439
——Blast-furnace. Howe. (N.) 459
——For gas industry. Fulweiler and Taussig. (N.) 290
——For industrial furnaces, Selection of. Bochow. (N.) 289
——For iron and steel industries. Nesbitt and Bell. (N.) 289
——Japanese industry. Kurohashi *185
——Magnesite, From American raw materials 704
——Rare earth oxide. Harding. (P.) 439
——Silica-fiber bricks. Wildcroft and Foster. (B.P.) 103
——Superior. Purdy. (N.) 290, 462
——Symposium on. (N.) 289

RESEARCH:

——Agricultural, Problems and methods. Wheeler. (N.) 279
——Appropriations for, Vassar and Columbia. 479
——Development of American. Karapetoff. 722
——Industrial, In small establishments. Leeds. *690
——In non-metallic mineral field. Ladoo. *348
——In petroleum industry. Manning 727
——On wood products, glue, paper, etc., at Forest Products Laboratory 759
——Organic chemicals for. Clarke 777
——Problems before Bureau of Standards 427
——Research and application. Nichols. (N.) 281
Resin, Synthetic, Cumar 456
Revere Sugar Refinery, A. I. C. E. visit 5
Richardson ball method for m. p. of asphalt 81

ROASTING:

——Blast-roasting, Effect on blast-furnace design. Mallette. 67
Roots governor for rotary gas exhausters. *99
Rosin, Bur. of Chem. collecting statistics on 223
Rosin, Use in paints and varnishes. Toch. 767

RUBBER:

——Action of accelerators. (N.) 430
——Industry, Data on. (S.) 401
——Meeting of Rubber Division, A. C. S. King. 429
——Physical testing. Simmons. (N.) 429

S

Safety Congress: (see National Safety Council)
Salicylic Acid, Manufacture of. Wightman and Robinson. (S.) 257
Salt manufacture in Michigan 330
Saltpeter: (see Sodium nitrate)
Schneider, Charles Eugene, receives Mining and Metallurgical Society medal 614
Screen, Mitchell electric vibrating *644
Sewage Disposal Committee, National Research Council. 170
Sewage disposal, Landreth electrolytic process. 772
Shale: (see Oil shale.)
Sharks, Leather from 580
Sharks, Uses for. Rogers. (N.) 284
Sheeting material, Exposure tests of. Hoyt. *142
Shellac, Origin, manufacture, grades, testing, etc. Jones 715
Shellac-naphthalene plastic. McCoy. (P.) 694
Shellac, Solution for stiffening felt hats. MacKenzie. (Aust. P.) 790
Siberian lakes, Glauber's salt in 771
Silicate of soda: (see Sodium silicate.)
Silicomanganese furnace record *752
Sillimanite, Artificial. Malinovzky. (N.) 468
Silver refinery fumes. Cottrell precipitator for. Smith and Heimrod *360
Sinter cake, Dwight & Lloyd, Ignition of. Adams. (P.) 48
Sintering. American process adopted at Swansea. 780
Slag. Copper in. Maier and Van Arsdale. (S.) *46
—— Correction. 61
Slide rule for SO$_2$ conversion. Blake. (N.) *285
Slide rule, Solving hydrometer problems by. Savage. *395
Smelting, Process and apparatus. Hampton. (P.) *642
Societe de Chimie Industrielle:
——October meeting. Report 533
Society of Chemical Industry:
——November meeting. 614
Soda pulp liquor, Sodium hydroxide from. McAfee. (P.) *256
Soda pulp, Washing unbleached. Griffin. (N). 528
Sodium aluminum chloride. Dutt. (B.P.) 472
Sodium nitrate, Removing borates. Calvert and Thomas. (P.) 211
Sodium hydroxide, Caustic soda plant at Edgewood Arsenal. Green *17
——From black liquor ash. McAfee. (P.) *256
Sodium silicate, Commercial, Properties of. Vail. (N) 293
Solders for aluminum. (S.) 101
Southern chemical industries. Little 710
Spain, Flotation monopoly in 178
Spain, Mercury production and exportation 448

SPECIFICATIONS:

——Fuel oil tanks and equipment 781
——Manganese ore for glass 198
——P and S limits in steel 556
——Paint and varnish 768
——Shellac and shellac varnish 720
Speisses, Treatment of complex. Papencordt. *30
Spelter: (see Zinc.)
Spruce Turpentine, Dyes from. Andrews. (P.) 743
Stainless steel. (S.) 438
Stanton, Wm. A. Obituary 647
Stencils, Sheet zinc 369
Sterilizers, Ozone and ultra-violet light *706
Stocks and Bonds, 56, 112, 162, 218, 268, 412
Storage batteries (see Batteries, Secondary.)
Storax, American, From red-gum tree 227
Strainer, pipe line 207
Sugar, Beet, Production in Michigan 333
Sugar, Exports from U. S. 363
Sulphidizing solution. Bacon. (P.) 211
Sulphite waste liquor, Alcohol from. McKee. (N.) 558
Sulpho cyanates for primers. Buell. (P.) 440
Sulphonic acids. Lapworth and Morris. (B.P.) 742
Sulphur, From metal sulphides. Helbig. (P.) 694
Sulphur dioxide-sulphur trioxide slide rule. Blake. (N.) *285

SULPHURIC ACID:

——Efficiency in the chamber process. Fairlie. (N.) 285
——Nomenclature. Sullivan 511
——Slide rule for SO$_2$-SO$_3$ conversion. Blake. (N.) *285
Sulphuryl chloride, Mfr. of. Pope. (B.P.) 103
Superphosphate: (see Calcium superphosphate.)
Surface tension, Effect on crystalline form. Desch *773
Swansea (Wales) iron works adopt American sintering process 780
Synopsis of Recent Chemical & Metallurgical Literature 46, 101, 155, 208, 257, 399, 438, 470, 578, 641, 693, 789

T

Tailings pond, Utah Copper Co. *223
Talc and Soapstone Producers' Association meeting 277
Tar separating process at Providence Gas Co. *94
Tanning, Fish leather 580
——Two-bath chrome process 489
Taylor system, Increased value of. Wintermeyer. (S) 470

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY:

—— Chicago meeting. Program 298
—— Report 528
Tennessee Copper Co. enters fertilizer field 138
Tests of men *185
Thermal conductivity of metals, Apparatus for. Wilkes *241
Thermal expansion, Stretched wire apparatus for measuring. Gray *667
Thomas process (see Iron and Steel, Processes)
Thorium nitrate, Mfr. at Welsbach Co. *501
Tilting furnace. Ports for. Aubert. (P.) *211
Timberlake tungsten bill 62
——House passes 255
Tin importation permitted 204
——In Bolivia. Reyes 60
Tin mines in Ardlethan (N. S. W.) 619
Titanium Pigment Co. 457
Titanox 457
TNT: (see Trinitrotoluene.)
Tower packing, Resistance to gas flow. Zeisberg 765
Trade marks, Japanese decision on 778
Trading-with-the-enemy act, Extension of 659
Trieste to hold sample fair 771
Trinitro-nitranilid for primers. Buell. (P.) 440
Trinitrotoluene, Government disposes of 577
——Hygroscopicity of. Huff 570
Tube mill lining *207
Tuberculosis, Campaign against 659
Tuberculosis, Industrial 635

TUNGSTEN:

——Boulder County, Colorado 275
——Chart showing uses of 201
——Consumption, 1918 200
——Peruvian situation 739
——Tariff bill passed by House 255

TUNGSTEN—*Continued:*
——Tariff hearings on 62, 120
——Wires, Manufacture by electrodeposition. Keyes. (P.) 48
Turpentine, Bur. of Chem. collecting statistics on 223

U

U. S., Chlorine-caustic soda plant. Green *17
U. S. Metals Refining Co., Cottrell precipitator at. Smith and Heimrod. *360
U. S. Platinum Corp. proposed 431
Utah Copper Co., Report 166
Utah Copper Co. tailings pond *223

V

Vanadium situation 222
Varnish, Use of rosin in. Toch 767
Ventilators for lead furnace forehearths. 118
Vici kid, Mfr. of 489

W

War Minerals Relief Act: (see Minerals Relief Commission.)
Warner Co., Charles, Lime plant *491
War risk insurance 418
War Trade Board transferred to State Dept. 63
Water glass: (see Sodium silicate)
Watertown Arsenal, Tests at 608
Waterpower Bill, House passes 65
——Bill, Senate to act on 178
——Government ownership of, In relation to electrochemical industry. FitzGerald 95
Water softening, Lime-barium process. Mehring *629
Water sterilizers *706
Weaver, William Dixon. Obituary 744
Webb-Pomerene law 228
Welding: (see Iron and Steel, Mechanical work.)
Welsbach Co. plant *497
Western Chemical and Metallurgical Field 117, 166, 222, 275, 418, 480, 512, 609, 704, 752
White lead: (see Lead salts.)
Wiedeman-Franz-Lorenz equation 566

Wisconsin:

——Chemical industries. Kowalke 338
——Hydro-electric and steam power plants *342
——Natural and industrial resources of. *335
——Raw material resources. Hotchkiss. *335
——Zinc in. Plumb 339

WOOD:

——Distillation of green and seasoned hardwoods *193
——Distillation of, Study of 764
——Drying kilns for 763
——Treated, Leaching ZnCl$_2$ from. Bateman. (N.) 292
Wood alcohol: (see Alcohol.)
Wood ashes, Potash from. Bateman *615
Woodpulp, Decay of 98
Wood waste, Ethyl alcohol from. Kressman. (N.) 558
Workmen's Compensation Acts: (see Legal notes.)
Wulfenite, Metallurgy of. Bonardi 364

X

X-cake flotation agent 418
——Correction 565
X-Ray examination of metals. Ruder. (N.) 546
X-Rays, Examination of metals, etc., by. 64

Z

ZINC:

——Belgian zinc industry. Chase 571
——Continuous extraction. Armstrong. (B.P.) 472
——Dust, Estimation of metallic zinc in. Edwards 192
——Electric radiant resistor furnace for distillation of. FitzGerald *737
——Electrodeposition of. Stevens. (Aust. P.) 790
——Improvement in sheet-ground region 736
——Industry in Wisconsin. Plumb 339
——Process for distilling zinc in electric resistor furnace. Thomson. (P). 211
——Recovery from low-grade and complex ores. Lyon and Ralston. (S.) 402
——Rolled and drawn. Mathewson. (N) 550
——Spelter production, U. S., 1917-1918 33
——Stencils of sheet zinc 369
——Use as electrical conductor in Germany *740
Zinc chloride, Leaching from treated wood. Bateman. (N) 293
Zinc ore, Tariff hearings on 62
Zinc oxide for rubber industry. Croll and Ruby. (N.) 430
Zinc roasting furnace. Rotatable valve for. Borcherdt. (P.) *643
Zirconium, Basic sulphate of. Pugh. (P) 742

*Illustrated; (P.), (B. P.), (Aust. P.), (Can. P.)—United States, British, Australian and Canadian patents, respectively; (S.)—Synopsis; (N.)—Papers read at society meetings but not printed in full.

AUTHORS' INDEX

ANDEREGG, F. O. Chemical industries of Indiana ... 324
Anderson, Robert J. Metallography of aluminum ingot ... 229
Ashman, A. O. Thermo-electric pyrometers for plant use ... 65

BADGER, W. L. Chemical industries of Michigan ... 330
Baily, Thaddeus F. Electrically heated soaking pits in the steel industry. 624
Bardwell, E. S. The design of electric furnaces. ... 479
Baskerville, Charles. Wood alcohol—Co-operative caution ... 733
Bateman, Ernest. Wood ashes and production of potash ... 615
Blakeley, A. G. Fusibility of ash from Pennsylvania coals ... 60
Bonardi, J. P. Notes on the metallurgy of wulfenite ... 364
Booth, Carl H. The Booth electric rotating furnace ... 636
Breithut, Frederick E. The economic status of American chemical industry .. 129
———Prices of chemicals during the war. 174
Brown, Frederick W. Does American potash need a fixed price? ... 446
Browne, F. L. Water-resistant glues ... 136
Brumbaugh, I. V., and R. S. McBride. Experimental-retort tests of Orient coal ... 171, 274
Buckley, J. P., E. B. Holland and J. C. Reed. An adiabatic bomb calorimeter .. 190

CAPPER, ARTHUR. The dangers of the postal-zone law ... 487
———The vicious postal-zone law ... 632
Carrier, C. F., Jr. The Nelson electrolytic chlorine cell ... 133
Chase, March F. Zinc industry in Belgium. 571
Clark, A. M. Vertical-cylindrical electric furnaces for heat-treating and shrinking ... 205
Clarke, H. T. Research organic chemicals. 777
Cleland, Harry E. Industrial magazines and labor conditions ... 682
Collins, E. F. Melting of some non-ferrous metals and their alloys in electric furnace ... 673
Coombs, F. E. Determination of maltose conversions ... 398
Crossett, Maj. Frederick M. Relations section, Chemical Warfare Service .. 613

DESCH, CECIL H. Effect of surface tension on crystalline form ... 773

ECKELMANN, L. E. Phosphatic coatings for rust-proofing iron and steel ... 787
Edwards, Junius David. Application of the interferometer to gas analysis ... 560
Edwards, W. F. Notes on the estimation of metallic zinc content of zinc dust. 192
Ericson, Eric John. The analysis of red lead 61

FEILD, A. L. Atomic structure of metals in solid solution ... 566
FitzGerald, F. A. J. Government ownership of water power in relation to electrochemical industry ... 95
———Radiant resistor furnace ... 737
FitzGerald, F. A. J., and Grant C. Moyer. Electric furnace for experimental work ... 769
Foley, Francis B. The photographing of etched sections of steel forgings at low magnifications ... 140
Freud, B. B. War Department deserts Chemical Warfare Service ... 274
Frey, Charles P. A new compensated heatmeter ... 259
Fries, Amos A. War Department deserts Chemical Warfare Service ... 416

GOLDENBERG, LOUIS A. Determination of sulphur and chromium in steel 628
Goodwin, H. M. and W. G. Horsch. Electrical conductivity and other properties of saturated solutions of copper sulphate in the presence of sulphuric acid ... 181
Gosrow, R. C. The design of electric furnaces ... 235, 479
Gray, Arthur W. Stretched wire apparatus for measuring thermal expansions 667
Green, Samuel M. The United States Government chlorine-caustic soda plant at Edgewood Arsenal, Edgewood, Maryland ... 17
Grier, Charles D. The electric furnace laboratory of the Bureau of Mines .. 574
Grossman, H. Chemical technology for college students ... 4

HAYWARD, RALPH A. Flakes in nickel steel gun forgings ... 116
Heimrod, A. A., and W. G. Smith. Application of the Cottrell process to the recovery of fume from silver refining operations ... 360
Hendrick, Ellwood. America's case in chemistry ... 684
———The Langmuir postulates ... 73
Hibbert, Harold. Potash recovery from blast-furnace gases in England ... 723
Holland, E. B., J. C. Reed and J. P. Buckley: An adiabatic bomb calorimeter .. 190
Horine, Karl. Electrolytic caustic soda-chlorine cells ... 69
Horsch, W. G., and H. M. Goodwin. Electrical conductivity and other properties of saturated solutions of copper sulphate in the presence of sulphuric acid ... 181
Horvitz, G. J., and L. R. Seidell. Relation of micro-structure to phase changes in heat-treated aluminum bronzes ... 179
Hotchkiss, H. O. Raw material resources of Wisconsin ... 335
Hoyt, Samuel L. Exposure tests of sheeting material ... 142
Huff, Wilbert J. Hygroscopicity of trinitrotoluene ... 570
Hulst, George P. Treating antimony ores .. 727

JONES, CHESTER H. The Forest Products Laboratory ... 757
———Power systems of the North Central States ... 342
———Pure gum shellac ... 715
Jones, G. W., and F. R. Nenmeister. An improved Orsat apparatus for gas analysis ... 734

KARAPETOFF, VLADIMIR. Development of American research ... 722
Kershaw, John B. C. British scientists in conference at Bournemouth ... 581
King, Andrew H. Meeting of the rubber division, American Chemical Society ... 429
King, J. T. New and rapid apparatus for electrochemical analysis ... 25
Kinnison, Charles S. An alloy which resists molten brass and bronze ... 608
Knapp, Ismond E. Carbide conversion calculations ... 139
Kowalke, O. L. Chemical industries of Wisconsin ... 338
Krynitsky, Col. A. I. Experience with a 91-9 copper-aluminum alloy ... 770
Kurahashi, T. Refractories industry in Japan ... 185

LADOO, RAYMOND B. The need for research in the non-metallic mineral field ... 348
Leeds, M. E. Industrial research in small establishments ... 690
Little, Arthur D. Chemistry and the South. 710
———University and college endowment .. 658
Logan, W. N. Raw material resources of Indiana ... 320
Lorenz, A. W. Fibrous structure in high carbon steel ... 208

McBRIDE, R. S., and I. V. Brumbaugh. Experimental-retort tests of Orient coal ... 171
McBride, R. S., and W. A. Selvig. The coking of Illinois coal in Koppers type oven ... 122
McClimon, J. S. Operation of a gas producer ... 633
Mallette, Walter K. Blast-roasting and its effect on blast-furnace design ... 67
Manning, Van H. Need of extensive research in the petroleum industry. 727
Marshall, A. E. The present status of labor in the English chemical industry ... 16
Mehring, C. A. Lime-barium softener for treatment of boiler feed water .. 629
Merten, William J. Heat treatment of 155-mm. high explosive shell ... 687
Miller, S. W. Relationship between transverse rail fissures, flakes and defects in fusion welds ... 729
Mitchell, F. H. The Allen-Moore cell in the pulp and paper mill ... 370
Mondell, Frank W. The menace of the postal-zone law ... 469
Moyer, Grant C. Electric furnace for experimental work ... 769

NEGRU, J. S. Chemical nomenclature and spelling ... 544
———Glucinum ... 353, 417
Neumeister, F. R., and G. W. Jones. An improved Orsat apparatus for gas analysis ... 734
Nichols, William H. Presidential address—Research and application ... 281
Northrup, E. F. Electric production of carbon-free alloys ... 258

OVITZ, F. K. Ammonia in producer gas. 253

PAPENCORDT, PAUL. Treatment of complex speisses ... 30
Parsons, Charles L. Chemical nomenclature and spelling ... 544
Phalen, W. C. Preparation of fuller's earth 469
———Uses of manganese dioxide ore ... 196
Plumb, A. M. Zinc in Wisconsin ... 339
Proctor, Leland M. Melting point of asphalts ... 81
Pulsifer, H. B. Industrial resources of the Chicago district ... 310

REED, J. C., E. B. Holland and J. P. Buckley. An adiabatic bomb calorimeter ... 190
Reyes, Juan M. Tin in Bolivia ... 60
Robson, James T., and James R. Withrow. The flash and burning points of gasoline-kerosene mixtures ... 244
Russell, Walter M. Manufacturing plant of the Providence Gas Co. I ... 34
II ... 88
III ... 147

ST. JOHN, H. M. Commercial testing of metallurgical electric furnaces ... 377
Savage, Wallace. Calculation of hydrometer degrees, gravities and weights with the slide rule ... 395
Schaeffer, John A. A rapid method for the analysis of red lead and orange mineral ... 274
Seidell, L. R., and G. J. Horvitz. Relation of microstructure to phase changes in heat-treated aluminum bronzes ... 179
Selvig, W. A., and R. S. McBride. The coking of Illinois coal in Koppers type oven ... 122
Seyt, Martin. Contributions by metallography to l'art nouveau ... 656
Sherlock, Chesla C. The explosion of chemicals—I. Common law liability ... 83
———The explosion of chemicals—II Workmen's compensation acts ... 131
———The liability for infections ... 252
———Patent rights and remedies ... 786
———Who are entitled to compensation .. 639
Simpson, Louis. Oil shales ... 176
Smith, R. A. Mineral resources of Michigan 326
Smith, W. G., and A. A. Heimrod. Application of the Cottrell process to the recovery of fume from silver refining operations ... 360
Sullivan, Thomas J. Sulphuric acid nomenclature ... 511

TAYLOR, T. S. A new compensated heatmeter ... 416
Thatcher, C. J. Commercial possibilities in the electrochemical production of organic compounds ... 663
Thompson, M. deKay. Potassium permanganate from ferromanganese by electrolysis ... 686
Thomson, Procter. Chemical industries of Illinois and the Chicago district .. 315
Thum, E. E. Description and activities of the Pittsburgh Station, Bureau of Mines ... 432
———Flakes in alloy steel ... 145
———Iron and steel plants near Chicago. 319
Toch, Maximilian. Use of rosin in paint and varnish ... 767
Turrentine, J. W. Growth of the kelp organism ... 202

VAN ARSDALE, G. D. Copper in slags .. 61

WEIDENTHAL, H. G. A square deal for the electric furnace ... 779
Wesson, David. History and development of the cottonseed oil industry ... 661
Wheeler, F. G. Observations regarding chlorine cells ... 436
White, Walter P. Some points regarding calorimeter efficiency ... 187
Wikoff, Alan G. Alignment chart for the gas laws ... 195
Wilkes, Gordon B. An apparatus for determining the thermal conductivity of metals ... 241
Wilson, C. H. Recording pyrometry ... 511
Withrow, James R., and James T. Robson. The flash and burning points of gasoline-kerosene mixtures ... 244

X. Y. Z. Electric brass melting ... 116

ZEISBERG, FRED C. Resistance of tower packing to gas flow ... 765

Published SEMI-MONTHLY *on the* FIRST *and* FIFTEENTH *of each month*

CHEMICAL
& METALLURGICAL
ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, July 1, 1919 *Number* 1

The Dawn of Peace

WITH whatever feelings we may have contemplated the procedure of the Peace Conference at Paris, there could be but one universal sentiment at the announcement of the Germans that they were ready to sign the treaty unconditionally. Men everywhere experienced a sense of relief, a feeling that the world had at last finished a nasty job and could go about its business, could afford to take at least one eye off the enemy and apply it to works of construction. True, events immediately subsequent to the declaration showed that not more than one eye could be detached for the present, and that watchfulness would be in order for some time to come. It is true also that the world still awaits retributive justice in the trial of those responsible for the war and the payment of indemnities to ravished Belgium and France. But on the whole there is a feeling that the pursuits of peace can occupy our attention. There will still be much political debate and argument, despite Lincoln's historic and classic recognition of the fact that "the world will little care or long remember what we say here," but that need not deter industry from putting its hand to the throttle and forging ahead. The future will be determined more by work than talk.

Co-operation Between Industry and University

WE PUBLISH in another column a letter from a student of chemical engineering in which the prospectus of an intercollegiate chemical society is outlined. It has for its purpose the establishment of a course of lectures on the technology of various industries and the details of large-scale chemical apparatus. The idea seems to us worth while. There is a considerable hazard of loss in breaking in nearly every student to factory practice, and this should be decreased by the course proposed. A trouble that has not been provided for in these lectures by manufacturers, works chemists and sales engineers of apparatus is that men who are not accustomed to lecturing are fully likely not to consider their time and get to the point without needless preambles and peroration. Usually it is like pulling teeth to draw information out of an unregenerate manufacturer—and by unregenerate we mean one that fears his neighbor as the devil, and who holds that all information relating to his industry should be privy to his establishment.

What we would like to see in chemical engineering courses is better training in industrial physics. After all it is more important to know why things are done and why results ensue then to learn how to do them. It takes very little explaining to teach a man how, who knows why.

Is Molybdenum a Metallurgical Mystery?

ONE of the minor metals which has witnessed some puzzling vicissitudes in fortune during war-time is molybdenum. Ten-fold increase in price caused quadrupling of output, whereupon the market became more or less nominal, and has remained stagnant for several months. Under these circumstances, miners of this material are naturally much concerned about the chances of future business, especially since molybdenum minerals are much more widespread and accessible than others, tungsten or vanadium as instances, and any probable demand could be readily satisfied.

Contradictory statements as to its uses have been so current as to dub molybdenum "the metallurgical mystery." KRUPP did absorb a great proportion of the available supplies, and captured German gun tubes have been variously reported as containing from zero to 6 per cent. No information as to similar use by an Allied government has come to notice. While the metal has a high melting point, it is said to change very readily into a volatile oxide, so that silver plating is necessary to get the alloy into the metal rather than the slag. Some gun tubes may have been de-molybdenized by heat, other analyses may have unfortunately confounded this element with carbon, while again, still others may have always been innocent of its presence, possibly due to the high price of silver!

Seriously, though, molybdenum steel is a demonstrated success. Quantities of it have been used in aëroplane engines, while many liberty motor crank shafts were made of a manganese-chromium-molybdenum alloy. Following extensive experimentation, one prominent automobile maker in the Detroit region ordered 10,000 tons of a special alloy containing a fractional per cent molybdenum, which is being used in forged or case-hardened parts demanding high strength and low weight. As such it should replace the vanadium steels already well established, owing to the comparative rarity of vanadium and to the fact that the new alloy does not require such close control in heat treatment; perhaps molybdenum acts as a brake in spreading transformations over a wider temperature range. The addition of molybdenum to nickel steels in small quantities increases the ductility remarkably.

Such are the uses of the future. At present considerable quantities of molybdenum are absorbed by tool-steel makers—the element is almost always present in modern metal-cutting tools.

Even granting the fact that molybdenum steel is a demonstrated high-strength material, it certainly will not be a panacea for all heat-treating troubles, and it is difficult to see any great boom in molybdenite in the near future. Mines and mills are already developed to such an extent that should their present excess capacity be put into molybdenum steel (averaging perhaps 1 per cent), 250,000 tons of this material would be produced per year. Picture the metallurgical knowledge which must be accumulated before iron-masters will be able to deliver uniform steel of this comparatively new analysis, the many obscure troubles which arise in the manufacture of the completed parts—some wholly new and baffling defect may vie with the notorious "flakes" of nickel steel in keeping metallurgists awake nights—picture the campaign of education necessary to make the purchasing agent recognize its value and the purchasing public demand minimum weight with maximum strength, and the conclusion is inevitable that widespread demand for molybdenum as a constituent for steel will not be a matter of months.

A Rose By Any Other Name—

ELSEWHERE in this issue the reader will find a communication from the house of Kuhlmann, Paris, protesting against the assumption of the German origin of its founder. Exception is taken primarily to a statement of Landis in his article on the oxidation of ammonia, to the effect that "eighty years ago Kuhlmann, a German technical chemist, etc.;" and proof is now offered that Kuhlmann was "a savant doubly French." We are glad to give space to the correction as further evidence of the myth of German preëminence in chemistry, which is growing less persistent as the facts in the history of chemistry come to light.

If we may boldly claim in this instance to represent average American intelligence among chemists, we can readily understand how Mr. Landis and probably the great majority of our readers, would accept innocently enough and quite as a matter of fact, a statement that Kuhlmann was a German chemist. For have we not been nurtured in the belief that chemistry and Germany were synonymous, and that the abode of chemical knowledge was beyond the Rhine? Couple this with the typical spelling of Kuhlmann, and we have all the elements necessary to an erroneous conclusion. But it appears that Kuhlmann was born in Colmar, Alsace, in 1803; was subsequently professor of chemistry in the University of Lille, and later founder of the 40,000,000-franc Etablissements Kuhlmann in Paris and elsewhere in France. He was a Frenchman by birth, education and all that characterizes one's nationality and mentality.

The last five years have developed awkward situations regarding the merits of the scientific and technical contributions of the several nations. It has been easy to foster extreme views and share partisan feelings. A large number of American technical men were of foreign birth or education. German literature had been widely read in this country, and it was perhaps logical that we should have assumed that Germany had led the way in all chemical progress. We have learned, however, that names are not safe tags of identification as to the nationality and mentality of the world's scientists; and in the present instance we are delighted to know that it was a French savant who early recorded the importance of the oxidation of ammonia to nitric acid. We render unto Caesar the things that are Caesar's and acclaim a French scientist even though he bears a German name.

Need of a Firm Policy in Mexico

WITH European affairs less engrossing than they have been for several years the United States has an opportunity to turn much needed attention to its Mexican relations. They need attention! For almost 10 years the interests in American mining and metallurgical companies operating in Mexico have suffered from the lack of protection of life and property. Murder, robbery, pillage and banditry have been committed and practised without effective interference or suppression and almost without protest. If the Government has had reasons for pursuing a weak policy with our Southern neighbor those reasons have not been disclosed to the country's satisfaction, and the people are beginning to feel that it is about time to abandon patience and yield to the impulses of righteous wrath. The policy of watchful waiting finds us still watching and waiting after nearly a decade, but almost hopeless of a firm governmental policy that will insure protection to Americans and their property. Conditions have been unsettled for so long that we have almost come to regard them as inevitable and something to be endured without remedy.

But there are hopeful signs. Congress has recently pressed the Administration for a statement of its policy, and Under-Secretary of State Polk is reported to have spoken "with complete frankness" to the House Committee on Foreign Affairs, laying the Administration's cards on the table. Firing across the border into El Paso has been stopped by an excursion of American soldiers into Mexican territory, apparently with Mexico's acquiescence. Of more than ordinary importance is the action of the Mining and Metallurgical Society of America in proposing resolutions of protest

> "against further disregard by the American Government of conditions in Mexico that make it unsafe for American engineers to go there in the practice of their profession and for the care of business interests intrusted to them";

and further urging

> "the American Government to take prompt and effective steps toward the establishment of such law and order in Mexico as will safeguard the persons and property of our citizens and extend its protection to all Americans in any part of the world to which they may be called in the pursuit of their legitimate affairs."

The Society is to be commended for this evidence of interest in Mexican affairs, and we see no reason why the American Institute of Mining and Metallurgical Engineers should not go on record with similar resolutions reflecting the attitude of the great mining industry. The Institute has recently amended its charter to permit participation in public affairs and expression of opinion on public questions affecting its members. At the moment we can think of no more opportune theme for the exercise of the Institute's newly acquired powers than advocacy of a firm governmental policy in Mexico. Dignified representation to the Government by influential bodies of citizens will hasten the dawn of a new era in Mexican relations that will be mutually beneficial. The people of the United States have been more than long-suffering in this matter, not only in toleration of Mexican lapses, but in refraining from unkind criticism of the Government's policy, whatever it may be. The elements of the situation seem to be comparatively simple and the remedy effective. It is futile to talk of Mexico's national honor when our own country is humiliated and insulted.

Automatic Control Devices In the Chemical Industries

TRUE to American traditions begun by substituting the harvester for the scythe, our inventors have not failed to design automatic mechanism endowed with about as much cerebellum matter as is required in ordinary routine work. The cobbler had his destiny foretold by the experiences of the nailsmith and the weaver. Is it only a matter of time before the chemical control operator will follow suit and pass his skill to the tools of which he will be merely a tender?

Tank gaging is far better done by the hydrostatic pressure recorders now coming into vogue than was ever accomplished by the most exact calculations obtained from volume and temperature measurements. Temperature control is almost an undisputed job for the thermostat. Solution gravities, concentrations, viscosities—all are coming within the scope of the automatic control devices operated by buoyancy floats, electrolytic conductivity or resistance balances, propelling resistance recorders, and similar apparatus.

The fairest solution of the question appears to be found upon examining the experience of the artist since the era of the camera. In the early days when sensitive plates were made with asphalt-lard coatings, and turpentine was the solvent used to dissolve the parts not polymerized by light, photography appeared unlikely ever to become a member of the fine arts. However, developments came about which demonstrated that the camera shutter was not to be a portal for the exit of the artist but an arch of triumph for conquests in science as well as art. The same must be true of such devices in the hands of the engineer. He must not be satisfied with rough initial developments and, above all, must not have the feeling that he will work himself out of a job by doing what he can toward developing automatic control devices. Relief from routine work will give the chemist opportunity for larger development.

Stability of Prices and Employment

IN time of prosperity one should prepare for adversity and *vice versa*. Business is prosperous, and is certain to be more so, for a period of years. Panics and industrial depressions can, perhaps, be prevented but the method has not yet been invented, much less put into execution. To err is human, and these occurrences result from the errors of men.

There are important new conditions, and if panics and depressions occur they will exhibit different phenomena than formerly. The Federal Reserve system, according to the judgment of experts, removes the possibility of a "money panic." The organization of labor, and the new ideals of labor, make it improbable that men will compete for work to the extent they have done in past industrial depressions. The depression of 1873-8 saw "dollar-a-day" labor, and in the depression of 20 years later there was the same development. Men are almost certain to insist, when there is not enough work for full employment, that the work be divided and hourly rates be maintained.

This change, by itself, would make an industrial depression more severe. When commodities are sold, or service rendered, whether the furnishing of electric current or the removal of dirt from one's clothes, part of the payment goes to the workmen involved and part to the capitalist who furnishes the facilities. If the volume of business decreases and the one party stands none of the loss the other party must stand a correspondingly greater loss. When capital does not secure a return there is no creation of fresh capital such as in times of prosperity would be reinvested and make more work for the people. Moreover, if the cost of labor does not decline the inducement of cheapness to the making of investments is removed. A census of the skyscraper office buildings in the country would probably show that the majority of them were placed under contract in times of relative depression.

Recurring to the Federal Reserve system, it provides means whereby funds can be secured by those who have credit. In the past such facilities have been largely lacking. To provide absolutely necessary funds capitalists have had to operate plants at a loss, not getting a new dollar for an old one. Such performances probably will be unnecessary.

Thus in the new order of things it seems probable that when there is a tendency to industrial depression both labor and capital will refuse to work for less money reward than formerly and thus the traditional readjustment will not be encouraged. It is not intended to deny that the probable occurrence of panics, other than money panics, and of industrial depression has been reduced. It certainly has not been shown, however, that the reduction is to zero, and it does seem clear that if such things do occur the means for recovery are reduced. It is like reducing the likelihood of the human system to yield to disease but at the same time reducing its power to throw off the disease, once the infection has occurred.

Every year brings its own joys and sorrows and so do changing conditions. The outlook for the investor is not gloomy, but bright, for there is another new condition that makes capital more valuable than ever. Common labor in the United States, over periods of years, will never be as plentiful as it has been. That comes from sociological and racial conditions, not from business or financial conditions, and represents a permanent change. As less work is to be done by common labor more work must be done by capital, by the creation of plant facilities pursued to the *n*th refinement of labor-saving efficiency. Instead of there being no room for new investments there is vastly more room than ever before, since the new labor conditions make the existing facilities much less efficient, relative to the supply of labor, than formerly.

What is necessary is that the investor be able to earn enough in the first few years of operation to safeguard him in case industrial depression comes. The investor must look upon this matter from a new viewpoint. In the past his philosophy has been that he must amass sufficient extra profit to enable him to write off a large sum from the investment to cover reduction in cost of duplication. In the new order of things such declines in the cost of duplication are likely to be much less severe than formerly but on the other hand the chances of unemployment may be greater. The investor should save, therefore, against the temporary period when his investment may yield no profit. It is clear, also, that the sooner one makes his investment and begins securing returns upon it the safer he will be for the future. Delay undoubtedly means loss. The world is going to move, and move rapidly, and one should move with it.

Readers' Views and Comments

Oxidation of Ammonia

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue for May 1, 1919, we note an article by W. S. Landis on the Oxidation of Ammonia, in the first paragraph of which occurs the following statement:

> "Eighty years ago Kuhlmann, a German technical chemist, after describing at length some very interesting experiments of his own, concluded with the significant remark, etc. . . ."

For reasons which are readily understood it is impossible for us to overlook the error in this statement regarding the nationality of Kuhlmann, who was a savant doubly French, because he was born in Colmar (Alsace) in 1803. Frederick Kuhlmann was professor of chemistry at the University of Lille, the great industrial city of Northern France, and it was there that he made a great number of researches in the domain of pure and applied chemistry.

Most of his works were first published in the Bulletin de la Société des Sciences de Lille; others in the Annales de Physique et de Chimie (de Paris).

His discovery of the oxidation of ammonia by catalysis with spongy platinum was described for the first time in a memoir entitled "Mémoire sur la Nitrification" published in Vol. 15 of the Bull. de la Soc. des Sc. de Lille which contains the reference cited by Mr. Landis.

Ingenious manufacturer as well as a great savant, Kuhlmann installed in 1825 in Lille a sulphuric acid plant, which was the cradle of the Kuhlmann plants now numbering 15 scattered all over France.

He died in 1881, correspondent member of the Academie des Sciences de Paris and Commander of the Legion of Honor.

At a time when the masterful discovery of Kuhlmann, exploited by a German, Ostwald, is justifying the prophecy of the French savant, we consider it our duty to attract the attention of our American friends to the evident involuntary error made by Mr. Landis, and we would be greatly obliged if you would make due correction in an early issue of CHEMICAL and METALLURGICAL ENGINEERING, for which we present you our thanks in anticipation.

ADMINISTRATEUR DELEGUE
ETABLISSEMENTS KUHLMANN

Paris, France.

Chemical Technology for College Students

To the Editor of Chemical & Metallurgical Engineering

SIR:—An authority on education once said that a fault of modern technical institutes was the failure of the instructors to establish proper relationship between book knowledge and practical, everyday technology. This is also true of chemistry, which brings me to the purpose of this letter.

There is in process of formation an organization called the Intercollegiate Chemical Society, the main purpose of which is to correct this condition. The following is an excerpt from the preamble to its constitution:

"It is highly desirable, especially in the undergraduate courses, to connect chemistry with the world of commerce as it has not been connected. This can easily be done by the co-operation of students and manufacturers. Many potential chemists have been lost because the applications of science have not been made apparent in lectures or laboratory work."

The Intercollegiate Chemical Society proposes to accomplish its purpose by inducing prominent manufacturers or members of their technical staffs to lecture to its members, if possible every fortnight, showing the technology of various processes and apparatus, and indicating the applications of laboratory practice to factory control. These would be supplemented by demonstrations on trips with the students through plants, whenever practicable.

The officers of the society are prepared to send to any manufacturer who is willing to contribute aid in this connection, a calendar of subjects studied, so that demonstrations of apparatus and lectures in industry may be co-ordinated with the course. The academic calendar includes thirty weeks of actual work. This provides for fifteen such discussions or demonstrations during the year. If we can secure the co-operation of that number of manufacturers, each will be asked for but one discussion or demonstration per year.

We are organizing branches of the society in a number of universities throughout the States and the purpose of this is to ask manufacturers in the chemical and allied industries to co-operate. I have spoken to a number of men well known in industrial circles and they believe the advantage that can be derived from such a plan will prove profitable to both students and manufacturers. With such training a student will be made more efficient and can take up his duties when entering an industrial plant with less likelihood of loss and delay by the exigencies of "breaking him in."

Students should have a more thorough understanding of the needs of chemical industries. This knowledge, combined with the fundamentals gained at the university, will help them recognize and eliminate wastes and increase yields as they advance in technical development. It will be an efficient way to connect theoretical chemistry with actual industrial conditions. It will also develop a tendency for young chemists to seek methods in which the achievements of pure science may be brought ever closer to industrial practice.

If manufacturers who are interested in providing for such demonstrations of industrial practice, or of apparatus which they make, will communicate with me I shall be glad to respond with whatever additional information they may desire.

H. GROSSMAN,
Acting Chairman.

Intercollegiate Chemical Society,
Columbia University, N. Y.

Surplus Government Lead

By arrangement with the Lead Producers' Committee of the War Industries Board, sufficient orders will be allocated to the War Department to take up the surplus stock of pig lead, which does not exceed 5000 tons. In addition, about 10,000 tons of heavy sheet lead, 25 tons of lead pipe and 6 tons of lead slabs will be disposed of without the assistance of the industry. The Director of Sales is also seeking a market for 1180 tons of antimonial lead and approximately 930 tons of antimonial lead scrap.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Meeting of American Institute of Chemical Engineers

Large Gathering at Boston and Cambridge—Interesting Visits to Places of Historical and Industrial Interest—Massachusetts Institute of Technology, A. D. Little, Inc., Harvard University—Symposium of Electric Furnaces

THE eleventh semi-annual meeting of the American Institute of Chemical Engineers at Boston and Cambridge, June 18-21, does not lend itself readily to a brief description. The excursion on the steamer "Gurnet" was the unique feature. Mr. Henry Howard, Director of the Emergency Fleet Recruiting Service and sometime of the Merrimac Chemical Co. endeavored to demonstrate by the trip to sea in the "Gurnet" just why he had such great interest in maritime pursuits. The Boston Fish Piers were visited first in order to furnish fresh material for future fish stories as well as to entrance all angling desires. About a million pounds per day of cod, haddock, mackerel, etc., were said to be the average of the season. Inspection of the cold storage department demonstrated that ample provisions have been made for many Fridays to come.

The second stop was made at the plant of the Revere Sugar Refinery. Thousands of tons of crude sugar, the Cuban in 200-lb. burlap bags and the Philippine in 50-lb. palm platted sacks, were stacked in the pier warehouses. In refining, the sugar is dissolved, limed and filtered in Sweetland presses. The syrup is then clarified by percolating it through animal charcoal and is then ready for crystallization in vacuum pans. After the grains have grown to the desired size, the sugar is discharged into open bins from which it passes into centrifugals, is freed from molasses and flushed with water sprays to remove both the finer crystals and syrup. Two or three percent of moisture remains in the centrifuged product and is removed in forty foot drum driers. The engineering involved in such a works is a model for the crystal type of chemical process. Every task is performed with a minimum expenditure of energy and labor. After the initial elevating of the crude syrup to the top floors, gravity does the rest. The packaging machinery was exceptionally good and since space does not permit more discription, only the names will be given. Bag Machine: Richardson Scale Co., Passaic, N. J. Bag Sewing Mach.: Union Special Machine Co. Chicago. Package Filler and Sealer: Pneumatic Scale Co. Norfolk Downs, Mass. Box Nailer: Morgan Machine Co. Rochester, N. Y.

While enroute to the Victory Shipbuilding plant at Squantum, the Edison Power Plant was passed. Also a brief inspection was made at the seamen training school. The visit to the Victory yard gave an excellent opportunity for a study of modern steel fabrication. Hundreds of riveting gangs put added vigor to their tasks and the red hot battered rivet heads in cooling drew the steel plates tightly together. In order that there should be no seams for water leaks at the joints, the calkers rammed the edges of the plates so that they were sprung flush. From the storage yard to the fitting out basin in a quarter of an hour was too brief a time to observe details. It is enough to say that torpedo boat destroyers will never be out of sight on our coast after a few years more of standardized fabrication.

Enthused after so many excellent plant visits along Boston harbor, the voyaging members did not seek to break away before the final event of the day—the trip out in the open water of Massachusetts Bay to Marblehead. The Gurnet being a small steamer of fifty odd feet length was soon effectively rocking and much to the satisfaction of the fishes. Of the one hundred and twenty six passengers, only half were found by the photographer the next day in happy enough condition to have their appearance registered in the annual June meeting panorama.

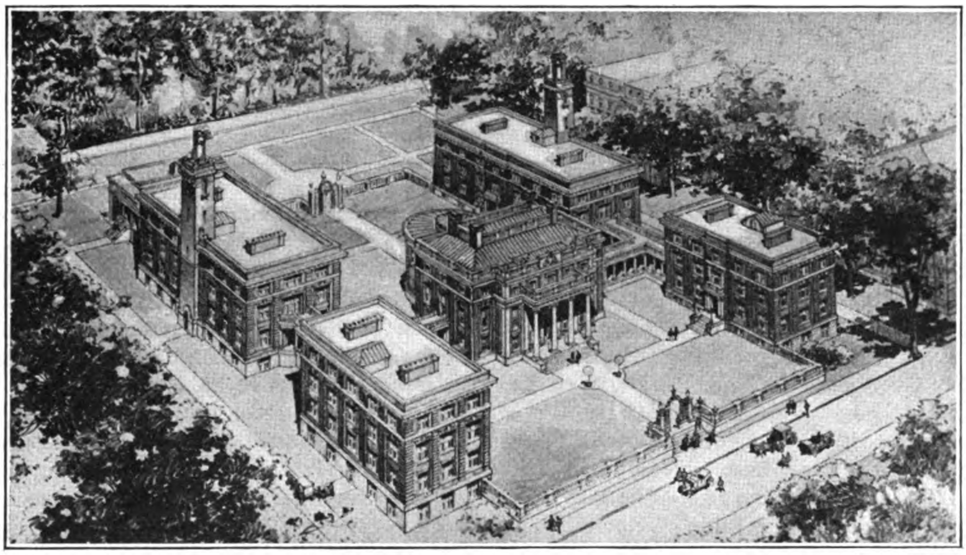
LABORATORIES IN CAMBRIDGE VISITED

On Wednesday night, a smoker was held in the assembly room of the A. D. Little, Inc. building. Every one was delighted with the arrangement of the laboratories and officies.[1] The paper mill was in operation and demonstrated the facilities with which Dr. Little's staff is equipped to carry on research in most of the large industrial chemical enterprises. The museum gave additional evidence of the great scope of their work and contains specimans of the greatest value. Mr. Ellwood Hendrick gave a humorous exhibit on electron furnaces in which he transformed a mixture of saw dust and like miscellaneous materials into fresh hot roasted peanuts. The remainder of the evening was devoted to fun, refreshments and song.

---

[1] For description see Chem. & Met. Eng., Vol. XIX, P. 100.

The new buildings of the Massachusetts Institute of Technology are marvelously compact. The right wing of the inner court, over which the illustrious names of Pasteur and Lavoisier are carved, is devoted to the chemical departments. The laboratories are, it is needless to say, the best that could be built. It comparing the chemical engineering equipment with that of some of the other engineering laboratories, the casual visitor might think that there was room for considerable improvement. The commercial size hydraulic, steam and electric power plants make the small Swenson evaporators look small indeed and they are the giants of the industrial chemical laboratory. However, Prof. Walker has overcome these difficulties and set all the other engineering divisions a new example. Technology instructors are now placed in several of the chemical plants around Boston and the students are given more than the birdeye view of the manufacturing business.



DIVISION OF CHEMISTRY, HARVARD UNIVERSITY

The Wolcott Gibbs Memorial Laboratory[1] is the forerunner of what might be called the Harvard College of Chemistry. A view of the group of buildings as now planned by the architect, Mr. A. W. Longfellow, is given. Dr. Morris Loeb, Mr. James Loeb, T. Jefferson Coolidge and several members of the alumni are the donators of of the first two buildings. These buildings will be instrumental in the development of pure and applied chemistry for generations to come and it is certainly a rare privilege that wealth has bestowed upon the founders which will enable them to contribute so much to the future welfare of humanity. Professor T. W. Richards personally welcomed the Institute. Though he was able to show the prize points of the laboratory such as 6-ft. drawers and other extraordinary facilities for research, the guests knew that their real opportunity was in visiting America's greatest chemist in the building entirely devoted to research under his guidance.

President A. D. Little introduced an amendment to the method of selecting candidates for membership whereby the admission committee could place those candidates up for election who do not quite meet all the specifications but have real meritorious qualifications. It is hoped to make the Institute the real representative body of the American chemical technologists and engineers.

Dr. David Wesson invited the society to be his guest at Savannah, Ga., at its winter meeting. Great cotton oil and naval store plants are located there, and not least of all, Savannah is the most typical of all southern towns.

PAPERS PRESENTED

The major part of the program was assigned to the symposium on electric furnaces. Extracts from three of these papers are included below and selections from the others will be given in a future issue. The Institute semi-annual report will be published shortly giving the texts in full. The Growth and Development of the Manufacturing Plant of the Providence Gas Company by Mr. W. H. Russell will be given in three parts. Dr. Chas. L. Palmer gave a splendid review of the gaps left in the chemical study of the wool grease. The most amusing debate was precipitated by Dr. Edward Gudeman's argument that chemists should be licensed. Dr. James R. Withrow, who was scheduled to support the issue, sidestepped the matter and Drs. A. W. Smith and David Wesson went at the argument so vehemently that the old western proverb which said, "Never stop to argue with a Smith & Wesson" certainly proved to be as wise a maxim for oratorical combats as those fought with lead.

Symposium on Electric Furnaces

The program for the symposium was arranged by Mr. C. T. Bragg of the Michigan Smelting & Refining Co. The first paper was read by H. W. Gillett, of which the following are extracts:

UTILIZATION OF ELECTRIC BRASS FURNACES

Four years ago there was no electric brass furnace in commercial operation. Today some forty firms are using or now installing approximately 100 electric brass furnaces. One rolling mill has about 30, though most of these are small 300-lb. furnaces. One smelting and refining company is using four one-ton and four three-quarter-ton furnaces. Another firm has four one-ton furnaces and the various offices of the U. S. Mint will soon have five furnaces. Batteries of two or three furnaces are quite common.

Five types of furnaces have advanced far enough so that the makers can cite truly commercial performances. Various other types are in the experimental or semi-commercial stage but are not yet on the market, and a few are on the market with some at least of the experimental troubles left for the purchaser. While recognizing that there is yet no perfect electric brass furnace, and that future development may produce a type superior to those now in commercial use, prospective users may properly pay first attention only to the types which have been commercially proven in users' hands.

---

[1] For full description see Harvard Alumni Bulletin, Vol. XV, No. 26, P. 424-429.

These types are (1) Direct arc type, with the Snyder as the only make as yet really used on copper alloys out of the dozen of that type that are used for steel, (2) the vertical ring induction furnace type (Ajax Wyatt), (3) the granular resistor, reflected heat type Baily), (4) the stationary indirect arc type (Rennerfelt), and (5) the indirect ore type with stirring of the melt (rocking furnace). Clamer,[1] Baily,[2] vom Baur,[3] Miller,[4] the writer,[5] and especially St. John[6] have previously discussed the possibilities and limitations of these various types and a mere summary is sufficient here.

The Ajax-Wyatt is the most efficient in use of power, uses up no electrodes, gives thorough mixing of the charge, perfect temperature control, and has the steadiest electrical load. It must be "primed" with previously melted metal after a shut-down and hence is not well fitted for 10-hour operation, though it can be used on 10-hour operation by keeping some current on and holding some metal molten overnight. The need for "priming" makes it difficult to change from one alloy to another. It has been mainly used on yellow brass, though it is applicable to red. Its greatest drawback is that so far no refractory lining has been found that will satisfactorily withstand the action of alloys containing over 3 per cent lead. It is best fitted for 24-hour operation on the same alloy. It could be mechanically charged.

The Baily is the least efficient in use of power, does not mix the charge, but has a steady electrical load and uses up no electrodes. This type cannot be powered as high as others without grave danger to the resistor troughs, and is hence at a disadvantage as to efficient use of power, especially on alloys of high melting point. It is best fitted for 24-hour operation. When used for 10-hour operation it is usually necessary to put power on part of the night to keep the empty furnace hot. It is not readily charged mechanically. It has poor temperature control, due to its heat storage and consequent sluggishness. It can be used on any alloy but is better fitted for yellow brass than for the higher melting alloys. Its greatest advantage is its simplicity of operation.

The Snyder or any other direct arc furnace is applicable only to true bronzes or other alloys low in zinc, 5 per cent zinc being the probable limit. It is entirely impractical for use on alloys high in zinc. The only installation used for copper alloys is used on leaded bearing bronze, the new lead being added in the ladle. Much lead is volatilized from the scrap in the charge, and much fume results, giving bad working conditions. The installation of Snyder furnaces has a very poor power factor, though this is not necessary in a direct arc furnace.

The greatest advantage of the Snyder furnace in its limited field is its adaptability to mechanical charging, which aids in securing large output and hence in reasonable power consumption. One drawback is the single-phase arc load.

The Rennerfelt or any other stationary indirect arc furnace is most applicable to alloys low in zinc. It has been used on alloys up to 22 per cent zinc with fair results, but as the zinc increases above 10 per cent the metal losses increase, and 10 per cent zinc is probably the economical limit of its application. It has met with decided success in melting cupro-nickel, bronze and silver at the Mint. It is not readily charged by mechanical means. The power consumption is fairly low.

The rocking type of indirect arc furnace is applicable to alloys of any zinc content, gives a low power consumption, is apparently efficient in small as well as large sizes, can readily be mechanically charged, has good temperature control and mixes the charge thor-

TABLE I. PERFORMANCE OF ELECTRIC BRASS FURNACES

Name	Type	Power Supply Kw.	Charge Lb.	Power Factor	Material	Output-Tons per Day on Material Given 10-hr. Operation	Output-Tons per Day on Material Given 24-hr. Operation	Power Consumption Kw.-Hr. per Ton on Material and Time of Operation Given	Consumption of Graphite Electrodes Lb. per Ton
Ajax-Wyatt	Vertical ring induction	30	300	85	Yellow brass	1 to 1½	....	300–350*	None
		30	300	85	Yellow brass	....	3 to 3½	225–310	None
		60	600	72	Yellow brass	2½ to 3	....	250–300*	None
		60	600	72	Yellow brass	....	6 to 7	185–250	None
Baily	Granular resistor	105	800–1500	98–100	Yellow brass	2½ to 3½	....	400–500*	None
		105	800–1500	98–100	Red brass	2½ to 3	....	450–550*	None
		105	800–1500	98–100	Yellow brass	....	6–10	275–350	None
		105	800–1500	98–100	Red brass	....	6–9	325–400	None
Snyder	Direct arc	100	600	35–70	Leaded bearing bronze	1½	....	380	—(Experimental test)
		300	2000	30–60	Leaded bearing bronze	....	12–18	260–320	3–5
Rennerfelt	Indirect arc	100	500	75–90	Red brass	1½	....	450–500	3–6
	Indirect arc	125	1000	75–90	Bronze	2 to 2½	....	375–425	3–5
		125	1000	75–90	Bronze	....	7–10	325–375	3–5
		300	2000	75–90	Leaded bearing bronze	....	10–16	300–350	3–5
Rocking	Indirect arc	40	125	80–90	Red brass	¾	....	400	—(Experimental)
		225	1300	80–90	Red brass	3½	....	325–340	2½ to 4
		225	1300	80–90	Red brass	....	8½	250–275	2½ to 4
		300	2000	80–90	Red brass	6 to 7	....	275–325	2½ to 4
		300	2000	80–90	Red brass	....	16–20	225–275	2½ to 4
		300	2000	80–90	Yellow brass	6 to 7	....	250–300	2½ to 4
		300	2000	80–90	Yellow brass	....	16–20	200–250	2½ to 4

* Including necessary night heating.

---

[1] Clamer, G. H., Melting Brass in the Induction Furnace, *Journ.* Am. Inst. Metals, Vol. 11, 1917, p. 381.

[2] Baily, T. F., Resistance Type Furnace for Melting Brass, *Trans.* Am. Electrochem. Soc., Vol. 32, 1917, p. 155.

[3] Vom Baur, C. H., The Rennerfelt Electric Arc Furnace, *Trans.* Am. Electrochem. Soc., Vol. 29, 1916, p. 497.

[4] Miller, D. D., The Electric Furnace as a Medium for Heating Non-Ferrous Metals, *Journ.* Am. Inst. Metals, Vol. 11, 1917, p. 257; *Met. & Chem. Eng.*, Vol. XVII, No. 9, p. 537.

[5] Gillett, H. W., and Rhoads, A. E., A Rocking Electric Brass Furnace, *Journ.* Ind. Eng. Chem., Vol. 10, 1918, p. 459; *Met. & Chem. Eng.*, Vol. 18, No. 11, June 1, 1918. Melting Brass in a Rocking Electric Furnace, *Bull.* 171, U. S. Bur. Mines, 1918.

[6] St. John, H. M., The Present Status of Electric Brass Melting, *Chem. & Met. Eng.*, Vol. 19, 1918, p. 321.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
31
32
33
34
35
36
37
38
39
40
41
42
43
58
59
60

1 J. S. MILLER, JR.
2 O. R. QUAYLE
3 F. C. ZEISBERG
4 H. W. FOX
5 A. C. LANGMUIR
6 WALLACE SAVAGE
7 G. M. DAVIDSON
8 F. W. FRERICHS
9 F. M. DE BEERS
10 HENRY HOWARD
11 PAUL R. CROLL
12 B. R. TUNISON
13 W. C. BAINBRIDGE
14 GEO. C. PUCKHABER
15 WALTER B. MURPHY
16 A. H. KRAUSE

33 DAVID WESSON
34 MRS. DAVID WESSON
35 MRS. H. K. MOORE
36 MRS. A. C. LANGMUIR
37 MRS. GEO. M. DAVIDSON
38 MRS. F. M. DE BEERS
39 MISS RUTH LANGMUIR
40 MISS OTTILIE PROCHAZKA
41 MRS. B. R. TIMISON
42 MRS. HENRY HOWARD
43 HUGH K. MOORE
44 JOHN C. OLSEN, Secretary
45 MRS. JAMES MUNN
46 MRS. WALLACE SAVAGE
47 MRS. G. A. PROCHAZKA

oughly. Its drawbacks are the single-phase arc load and the possibility of electrode breakage in rocking too early if unskillfully operated.

The performance of the various furnaces properly operated may be expected to lie in the ranges set forth in Table I.

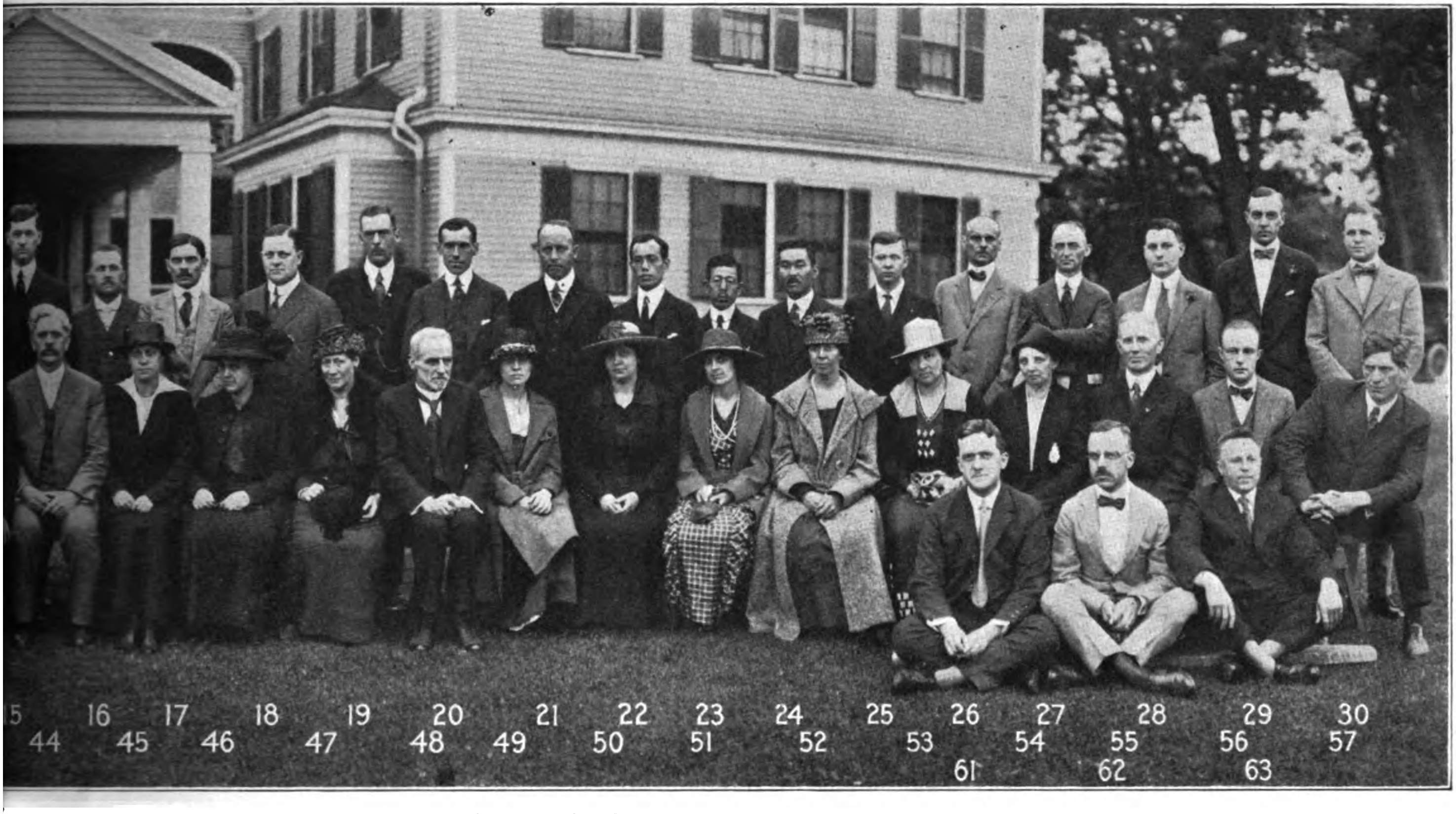
The figures in Table I do not in all cases agree with the catalog claims of the makers of the furnaces, as they are based on data obtained both from makers and users. The output and power consumption depend not only on the analysis of the charge, but also on the condition of it, i.e., whether all ingot, heavy scrap, light scrap, borings, or mixtures, as well as on the way the furnace is operated, just as gasoline consumption varies with the roads and the way the car is run. It will be noted that there is a wide variation in power consumption among the various types of furnaces, and that for the same type, the efficiency increases with the size.

If the types of furnaces unfit for use on alloys high in volatile metals are confined to use on alloys free from or sufficiently low in such metals, and if the furnaces are kept tightly closed after the charge is melted, all types of electric furnaces will give very low metal losses indeed. No fuel-fired furnaces can compete with properly chosen electric furnaces on this score. Of course, the lost metal is mainly zinc and lead, so that the value of the loss in fuel-fired furnaces is not as great as it would at first sight appear to be when the percentage loss is considered. This loss, however, usually amounts to about as much as the fuel or labor cost, and, even with cheap zinc and lead, is worth eliminating.

In making a choice of furnaces the user must first eliminate those types which will not operate satisfactorily on alloys he must melt in them, for example, the rolling mills making yellow brass would thus eliminate the direct arc and un-rocked indirect arc furnaces, and the makers of alloys high in lead and the people who must change from one alloy to another often would eliminate the Ajax-Wyatt. The user should then select from the remainder the type and size of furnace which will best fit his particular work. If he has very cheap power available, the granular resistor type may be chosen over a more efficient arc furnace because of the avoidance of electrode consumption. Where power is high, the balance would be against the granular resistor type. One rolling mill may prefer to continue to pour very small billets and may find the Ajax-Wyatt exactly suited to its needs. Another may wish to operate on a larger scale and may find a one-ton rocking furnace more suitable. A maker of bronze who must take his power from a very small power plant may find that a single-phase arc load would be unacceptable to the central station and hence might choose the two-phase Rennerfelt instead of the single-phase rocking furnace.

The size of furnace chosen will depend on the output desired and on whether 10- or 24-hour operation is called for. While the largest size furnace that can be kept busy should be used, it is poor economy to purchase a large furnace and then operate it with charges much under its capacity or to allow it to lie idle a good share of the time.

An electric furnace is expensive in first cost. The one or two furnaces required to melt 5 tons per day on ten-hour operation will cost from $10,000 to $20,000



17 W. ASEF
18 C. L. BRYDEN
19 WALTER M. RUSSELL
20 G. A. PROCHAZKA, JR.

48 GEORGE A. PROCHAZKA
49 MRS. P. R. CROLL
50 MRS. JAMES BROWN
51 MRS. W. O. BAINBRIDGE

21 G. L. OSTGREN
22 HANBEY SHIMIDZU
23 MASAMOTO INOUYE
24 YOSHIICHI TADA

52 MRS. A. L. GARDNER
53 MRS. A. H. KRAUSE
54 MRS. W. O. QUAYLE
55 W. O. QUAYLE

25 P. E. KRAUSE
26 W. S. PUTNAM
27 C. D. CARPENTER
28 J. M. WEISS

56 P. S. BARNES
57 CHESTER G. GILBERT
58 R. L. DAVIDSON
59 H. S. DAVIDSON

29 H. L. SHERMAN
30 JAMES MUNN
31 A. M. BRECKLER
32 A. L. GARDNER

60 ROBERT P. CALVERT
61 JAMES BROWN
62 STEPHEN L. TYLER
63 GEORGE P. HAHLWEG

completely installed. For purposes of calculation assume the cost to be $15,000. At 300 days per year the output is 1500 tons. Taking interest at 6 per cent, the interest is $900 per year or $3.00 per working day, this amount being lost every day the furnace is idle. At full output the interest charge is 60c. per ton.

On the other hand, if one furnace costing $10,000 is operated for 300 days per year 24 hours a day with an output of 16 tons, the total output is 4800 tons, and daily interest charge $2.00 per day, or 12½c. per ton.

On account of the initial cost and the interest charge, one should in general not have electric furnaces standing idle to handle small peaks of production in excess of the normal, but should utilize for this fuel-fired furnaces of lower initial cost.

On the other hand, the greater the number of electric furnaces which can be kept busy the lower the cost of power per ton.

BASIS OF POWER RATES

Industrial power contracts usually have two factors, the demand charge and the energy charge. The first pays the power company for the equipment it must maintain to supply the maximum power needed, while the second depends on the total amount of power used.

Suppose we have a maximum demand of 300 kw. and that the average power consumption per ton of metal is 335 kw.-hr. per ton on 9-hour operation, 275 on 18-hour, and 250 on 24-hour. The total power used per day is then about 2000, 3565, or 5250 for the three cases. In a 25-day month this makes 50,000, 91,000 and 130,000 kw.-hr. per month.

Assume that the plant, before it installed its electric furnace equipment, had a maximum demand in lights and motors, of 200 kw., and used 20,000 kw.-hr. per month for those purposes. Taking a concrete case where the power contract calls for a demand charge of $1.80 per kw. per month for the first 50 kw. and $1.00 per kw. per month for all over 50 kw., and the energy charge schedule is

2500 kw.-hr. per month at 2.0c. per kw.-hr.
for the next 35,000 kw.-hr. per month at 0.8c. per kw.-hr.
for the next 310,000 kw.-hr. per month at 0.5c. per kw.-hr.
all over 347,500 kw.-hr. per month at 0.4c. per kw.-hr.

The 200 kw.-20,000 kw.-hr. lighting and motor power cost

50 × $1.50 = $75.00
150 × 1.00 = 150.00
$225.00 demand

2,500 × 2.0c. = $50.00
17,500 × 0.8c. = 140.00
$190.00 energy charge

Total $415.00 or 2.07½c. per kw.-hr. used.

The plant now has 500 kw.-hr. maximum demand, and 70,000, 111,000, 150,000 kw.-hr. used per month on the three assumptions.

50 × $1.50 = $75.00
450 × 1.00 = 450.00
$525.00 demand

Energy—case 1—2,500 × 2.0 = $50.00
35,000 × 0.8 = 280.00
32,500 × 0.5 = 162.50
70,000 $492.50 energy
525.00 demand
$1017.50 total charge
less 415.00 previous charge for lights and motors
$602.50 total charge for electric furnace power

$$\frac{602.50}{70,000} = 0.860$$

The electric furnace costs 0.860 c. per kw.-hr.

In case 2 we have the same demand charge, but the energy charge is

2,500×2.0=	$50.00	
35,000×0.8=	280.00	
73,500×0.5=	367.50	
111,000	$697.50	energy
	525.00	demand
	$1222.50	total
less	415.00	lights and motors
	$807.50	total charge for furnace power

$$\frac{807.50}{91{,}000}=0.89$$

The furnace power costs 0.89c. per kw.-hr.

In case 3 we have

2,500×2.0=	$50.00	
35,000×0.8=	280.00	
112,500×0.5=	562.50	
	$892.50	energy
	525.00	demand
	$1417.50	total
less	415.00	lights and motors
	$1002.50	total charge for furnace power

$$\frac{1{,}002.50}{130{,}000}=0.79c$$

The furnace power costs 0.79c. per kw.-hr.

And, if in case 4 the plant had three times the furnace installation figured above and used it 24 hours a day, or 900 kw. furnace demand 1100 kw. total, 450,000 kw.-hr. per month furnace energy, 470,000 total, the charge would figure

50×1.50	75.00	
1050×1.00	1050.00	
	$1125.00	demand
25.00×2.0=	$50.00	
35.000×0.8=	280.00	
310.000×0.5=	1550.00	
122.500×0.4=	490.00	
	$2370.00	energy

	$2370.00	energy
	1125.00	
	$3495.00	total
less	415.00	lights, motors
	$3080.00	total for furnace power

$$\frac{3{,}080.00}{450{,}000}=0.685c.$$

The electric furnace power costs 0.685c. per kw.-hr.

Tabulating these we get Table II.

TABLE II.

Case	1	2	3	4
Hours	9	18	24	24
No. furnaces	1	1	1	3
Kw.-hr. per ton	335	275	250	250
Power price per kw.-hr	.860	0.89c.	0.79c.	0.685c.
Cost per ton for power	$3.92	$2.45	$1.98	$1.71

This table shows the advantage of continuous operation of electric furnaces, as well as that of large installations. The exact figures will vary in each particular case, but the ratios will remain approximately the same.

The elimination of delays will give a 25 per cent increase in output in an hour's less time, and decreases the cost of power per ton by about 40c.

The cost of power is in most cases the largest single item in melting costs in electric-furnace practice. Every effort must then be put forth to keep this cost down. The way to do this is to keep the furnace at work at its job, which is melting metal. This is important on 24-hour operation, but even more so on 8- to 10-hour operation, for an extra heat per day on single-shift operation means that it is obtained at the end of the day when the furnace has recovered from cooling off through the night. Any furnace will illustrate this fact. Take an actual day's run of a small Rennerfelt on red brass for example.

Heat	Charge Lb.	Total Time	Arc On	Idle Time	Kw.-Hr. Used	Kw.-Hr. per 100 Lb.	Notes
1	497	2:45	2:05	40	211	42	Furnace at red heat from previous day's run.
2	522	1:45	1:25	20	130	25	
3	527	2:55	1:10	1:45	105	20	Delay waiting for molds.
4	523	1:25	1:05	20	106	20	
5	394	1:25	1:10	15	94	25	Waiting for molds, so held power input low.
	2,463	10:15	6:55	3:20	646	26	Av. or 520 kw.-hr. per ton

This could have been run as follows, by eliminating all delays:

Heat	Charge, Lb.	Total Time	Arc On	Idle Time Charging and Pouring	Kw.-Hr.	Kw.-Hr. per 100 Lb.
1	525	2:10	1:55	10	215	41
2	525	1:40	1:25	15	130	25
3	525	1:25	1:10	15	105	20
4	525	1:20	1:05	15	100	19
5	525	1:20	1:05	15	100	19
6	525	1:20	1:05	15	100	19
	3,150	9:15	7:45	1:30	750	24 av. or 480 per ton

With the exception of the granular resistor type in which it is difficult to hold metal after it is once ready to pour because the response to changes in power input is so slow, it is possible to hold metal ready to pour as long as one likes in any of the electric furnaces. This is a convenience in an emergency, but it is very poor practice from the point of view of furnace efficiency.

In addition to using efficient discharging and charging devices, another way that power can be saved in electric melting is to operate on a definite schedule of power used. The Ajax-Wyatt takes power at so steady a rate that a time schedule works just as well on that type, but the granular resistor furnace and the arc furnaces may vary considerably in rate of power input. After a few test runs, one can, for any particular alloy, particular proportion of ingot, scrap and borings, and for any particular weight of charge, make out a perfectly definite schedule of kw.-hr. needed on each heat. In 10-hour operation the kw.-hr. per heat will be higher in the morning and approach or reach a lower constant figure at the end of the day.

By adhering to such a schedule and running on kw.-hr. input instead of on a time schedule at a supposedly constant but actually variable kw. input, the heat can be brought out with astonishing regularity as to temperature. Each furnace should have its individual kw.-hr. meter, and one readable to certainly not less than 5 kw.-hr., and better 1 kw.-hr. With individual kw.-hr. meters the performance of each furnace in a battery, and of each furnace tender can be watched.

Inasmuch as the heat losses through the walls and the electrodes are approximately constant even though the rate of power input may change, it is obvious that the higher the rate of power input, the more of it is usefully employed in melting. Suppose a furnace takes 100 kw. and loses 35 kw. through shell radiation and electrode losses, 65 kw.-hr. then do useful work. If the same furnace is given 125 kw. it may lose 37½ kw. in shell and electrode losses, but 87½ kw. do useful work. The furnace will do one-third more work in a given time at the higher rate. The upper limit of rate of input is that at which the local temperature is so high that refractories fail or that local overheating of the metal and consequent loss of volatile metals ocur. It is quite probable that on the larger furnaces automatic control of power input would be desirable.

ELECTRIC FURNACES OF THE RESISTANCE TYPE

Mr. T. E. Bailey illustrated his paper with moving pictures. The following are selections from his paper:

The principal factors taken into consideration as necessary to the development of a successful brass melting furnace were (1) the metallurgical requirements (2) the mechanical features (3) the electrical characteristics (4) the thermal efficiency (5) the commercial economy as compared with other types of melting equipment.

The obvious advantages to be found in an ideal electric furnace over fuel fired types for melting were (1) the elimination of crucibles, which are one of the principal costs in the melting of brass in pit type furnaces (2) the reduction in metal loss when handling zinc mixtures, on account of the slight vacuum under which all pit type furnaces are required to operate (3) the inability to maintain a reducing atmosphere in the furnace when operating with any degree of fuel efficiency, and (4) the fact that copper alloys, as well as copper, have a high affinity for the absorption of undesirable gases when in their molten condition, this being equally true of other alloys and non ferrous metals, such as aluminum.

Before the development of these furnaces for brass melting, a careful survey was made as to the adaptability of the more common types of furnaces then widely in use in the melting of steel, to determine whether such furnaces could be readily and successfully adapted for brass and other non ferrous melting operations; and if they could be, with what degree of commercial efficiency, as compared with the resistance type of furnace we then had under consideration.

When considering the use of the true resistance type furnace as it might be applied to the melting of non ferrous metals, the following points were given consideration

(1) That the metal should be contained on a true open hearth, and that the heating element should be entirely independent of the metal.

(2) That the heating element should be such that there would be a comparatively slight difference in temperature between this heating element and the bath, so as to overcome the objectionable features offered by the arc type furnace.

(3) That it should be feasible to tightly close the furnace in order to keep the molten metal under a pressure, however slight, and to prevent, as well, any draft of air through the furnace chamber.

(4) That the electrical characteristics of the furnace as applied to power factor should be such as to overcome the objections present in the induction furnace, and that the wide power variation present in the arc furnace should be, if possible, eliminated.

(5) That the furnace should not be subject to rapid changes in temperature from the most desirable ruling temperature for any particular melting operation.

(6) That the furnace should be as compact as possible, in order to reduce radiation losses to a minimum.

In this latter case, while the resistance type furnaces about to be described require a somewhat larger shell for a given melting capacity than either the arc or induction furnace, the absence of the highly localized temperature does not produce such a serious condition with regard to refractories; and the lower temperature with which the resistance element in a resistance type furnace operates, enables a higher degree of heat insulation to be used, so that the thermal efficiency of resistance type furnaces compares favorably with other types—with the exception, perhaps, of the induction furnace, whose higher thermal efficiency is seriously offset by its higher renewal and repair cost.

One of the mechanical features taken into consideration before determining on the type of furnace to be used was whether it was necessary, in order to obtain perfect alloying, to provide some oscillating motion, such as was originally used on the Stassano stool furnace; but when considering that substantially all copper alloys, with the exception perhaps of lead, diffuse completely when the proper temperature and melting conditions are reached, this additional complication was dispensed with, the only agitation required being the stirring in of the spelter previous to pouring, and this stirring is only required in order to facilitate the more rapid diffusion of the alloy.

The only materials in the furnace described in this paper that need regular renewal are

(1) the resistor troughs themselves, which are made of carborundum, fire sand and water glass, and were formerly tamped into place in the furnace with the aid of wooden forms, but are now made in sections at our works and baked ready for placing into the furnaces;

(2) the electrodes for leading the current from the cable terminals through the furnace walls and into the resistor material;

(3) the resistor material itself, which consists of broken carbon crushed to about ¼" mesh.

Under average working conditions, the fire sand troughs, and a pair of electrodes will last from three to four months, while the resistor material requires additions to it of fresh material every two weeks. This latter is accomplished in the small tilting furnace by raising the roof through the medium of three screws which are operated simultaneously by a hand wheel on the back of the furnace operated through sprockets and mitre gearing.

Some months ago for a period of time, some difficulty was experienced with resistor troughs, but a careful and exhaustive investigation brought to light that this trouble was experienced only when the analysis of the fire sand indicated an imperfect mix; and since all this material must now pass laboratory inspection, no difficulty is experienced from this source.

The furnaces now to be described are built in two regular types, the first, which has found wide applications in foundries, is of the round tilting type; while the other, of rectangular shape, is the type used for melting large tonnages and for smelting operations.

The round type is provided with a circular resistor trough with the electrodes coming into the trough diametrically opposite each other, the resistor material being renewed by lifting the roof, as previously stated; while in the rectangular type, the resistor troughs are two in number and placed longitudinally along each side of the hearth, and are, therefore, straight. The resistor material, in this case, is charged by means of long shovels through a door at each end of the furnace and directly above the trough. This furnace is a standard 105 K.W. trunion type with a rated hearth capacity of 1500 pounds and a melting rate of 600 pounds per hour. These capacities, however, have been in numerous cases materially exceeded, as much as 2 tons having been placed in a furnace at a time, and the melting rate increased to more than 1000 pounds per hour, when operating under exceptionally favorable conditions.

This furnace consists of a steel shell made of ½" plate seven feet in diameter and approximately 6′ high, mounted on the usual cast iron trunions and brackets, and having the usual hand wheel tilting mechanism.

The interior wall of the furnace is substantially 5½″ in diameter, with a wall of circular brick about 4½″ thick. The space between the brick wall and the steel shell is filled with kieselguhr insulation. The steel roof ring is adopted to hold securely the skew backs of the domed arch, and is provided with a lower fin for dipping into the sand seal. The space above the trough dome and below the steel top is also filled with kieselguhr in the same manner as between the fire brick walls and the steel shell of the furnace proper.

The hearth is located in the bottom of the furnace and is composed of a mixture of carborundum fire sand and plastic clay material bonded with silicate of soda. The resistor trough is located above the bath and completely encircles the rim of the hearth line, although located a considerable distance above it, and is set on fire brick piers, so that the heat from the lower part of the fire sand trough is readily dissipated from this part of the trough within the furnace chamber.

This feature is of vital importance in the successful design and operation of resistance type furnaces, as all early experiments with furnaces of this type without this feature resulted in failure.

The resistor material contained in this trough, and into which the electricity is introduced by means of the two carbon electrodes, as previously mentioned, radiates the heat generated in it to the roof of the furnace and thence down onto the hearth; while the heat coming from the lower part of the trough between the supporting pillars, is also radiated directly to the bath. That this resistor ring has a radiating surface of over forty square feet accounts for the fact that there is no highly localized temperature in this furnace.

The control of the furnace is obtained by means of impressing the various voltages on the low tension side of a special transformer across the furnace terminals by means of a special selective oil break switch. The special transformer supplied with each furnace is wound for any convenient line voltage, while the secondary of the transformer is provided with various voltage taps, usually giving a voltage ratio of two to one on the low tension side. By means of this arrangement, the electrical losses are reduced to a minimum, and an accuracy of control obtained that is not possible by other types of equipment, and it is readily possible to operate over long periods of time without a greater variation in electrical input than a few per cent.

The only opening to the furnace, which is used for charging the material is provided with a swing type plug door, the hinges being made of cast steel and attached to the furnace shell in a rugged manner. The pouring spout is a groove underneath the door, which enables the molten material to be poured without opening the door, the door itself being opened only during the charging or rabbling time. A false door, consisting of a ribbed cast iron plate, is also provided, so that when the main plug type door is open during the charging or rabbling operations, this false door can be dropped down, shielding the operator from the direct heat of the furnace interior.

This 7′ diameter furnace is also built in a nose tilting type, and is operated by means of a motor driven screw mechanism at the rear of the furnace. In this type of equipment the charging door is placed at the rear and a small opening arranged at the front for pouring the molten metal. This is a type of equipment that is particularly well adapted for pouring directly into molds, and is especially well adapted to casting rolling mill slabs, when used in connection with a rotary casting table.

The casting table is adapted for a vertical adjustment of 40″ for taking care of molds of different heights, and its turning motion is imparted by means of a motor driven vertical pinion engaging a circular rack attached to the movable table, the molds being attached to the top of the table in the usual manner.

The furnace is provided with a single resistor trough located directly above the bath, with the electrodes entering at the side. This type furnace is particularly well adapted to the smaller foundries or plants where a wide variety of mixtures are handled in relatively small quantities. The electrical characteristics of this furnace are similar to those of the furnaces just described.

Of the stationary non-tilting furnaces referred to in the fore part of this paper, the smaller size is of 500 K. W. capacity, and is adapted to hold 10 tons of brass or 3 tons of aluminum. This furnace has a resistor trough of the usual type located at each side of the bath, which is supported on the usual fire brick pillars. The doors in this case are located at each end of the furnace and are of the sand sealed type.

The furnaces described in this paper are the results of years of experience, first in the development and operation of furnaces for the annealing and heat treating of steel, and later a wide experience over the last several years in furnaces built especially for the melting of brass and other non-ferrous alloys, which it is believed will find a wide application throughout the non-ferrous industry, not only in brass foundries and rolling mills, but also in melting and refining in smelters. This is particularly true of the furnace described for melting cathode inc, which it is believed will find a wide application in the melting of cathode copper, which latter operation has been accomplished in furnaces of this type without the usual blowing and poling necessary in refining; and producing copper wire bar or ingot of substantially the same analysis as the copper cathode, the finished bar or billet, having only that amount of sulphur contained on the cathode as charged and coming from the electrolyte.

As an example of what may be accomplished and of the comparative amounts of sulphur contained on the edges of the cathode sheets as compared with the center, a quantity of copper cathode was obtained and the edges of the sheet to a depth of about 2 in. sheared off. This material was melted in one of our standard 105 K.W. furnaces and cast into pig. The analysis of the bars so cast is shown in Table A below, while the result from the melting of the inner part of the sheet are shown in Table B.

TABLE A

Analysis:

99.904 Cu.	.084 O.	.0021 S.	Conductivity 100.1

TABLE B

99.950 Cu.	.036 O	.0012 S	Conductivity 100.8

In the remelting of clean scrap, wire and similar substantially pure copper materials, it is found that this clean scrap can be remelted without any deterioration in the quality whatever, and furnaces of the character described in this paper will undoubtedly shortly come into general use for not only the melting of copper cathodes, but for the remelting of rolling mill scrap as well.

In the development of these melting furnaces constant attention has been paid to such features as were deemed necessary for the production of equipment that could operate over long periods of time without shut down, having good electrical characteristics, convenient and accurate control of both the metallurgical and thermal characteristics, and which could at all times operate under reasonably high efficiency, but no attempt has been made to sacrifice the qualities of ruggedness of design and reliability of operation to the mere consideration of current consumption under test conditions.

ROCKING ELECTRIC ARC FURNACE

Mr. H. M. St. John reviewed the factors involved and then showed how this type of furnace fitted them as follows:

The rocking electric furnace consists essentially of a cylindrical steel shell, lined with suitable refractories, and mounted on rollers and ring gears which permit it to be rocked through any desired arc of revolution up to a maximum of 200 deg. This rocking motion is actuated by a small induction motor through a reducing gear immersed in oil and enclosed in a tight gear case. The action of the motor is controlled by an automatic reversing switch which may readily be set to give the desired angle of rock. The source of heat is an electric arc between horizontal graphite eelctrodes axially placed in the furnace and meeting at the center of the cylindrical melting chamber. These electrodes are controlled by hand wheels which permit them to be entirely withdrawn from the furnace chamber when so desired. One of these electrodes is set in such a way as to locate the arc approximately at the center of the furnace and is thereafter allowed to remain stationary, while the operator controls the arc by adjustment of the other electrode.

During charging the electrodes are withdrawn until their tips are flush with the inner wall of the furnace in order to avoid striking them with heavy pieces of metal which might cause breakage. The furnace is then closed, the electrodes brought to the operating position, and the arc started. During the first few minutes of the melting period the furnace is not rocking, since rocking at this stage is unnecessary and might cause electrode breakage if started prematurely. As the metal becomes soft, rocking is started, through a small angle at first and reaching a maximum rock as the metal becomes completely molten and enters the superheating stage. During this complete rock the molten metal washes the inner lining of the furnace to within a few inches of the charging door at either end of the oscillation, at the rate of approximately two complete oscillations per minute.

When the charge is molten, it lies in the lower half of the furnace cylinder at a distance of from seven to ten inches from the arc. The metal is heated by conduction from the entire refractory lining as well as by direct radiation from the arc. The stirring action due to the constant rocking motion of the furnace is sufficiently effective to maintain a constant temperature throughout the melt and thus prevent the surface overheating which would result if the furnace were stationary.

When the melt has reached the desired pouring temperature, the arc is broken and the metal is poured through the spout beneath the charging door. The door itself is not opened until the furnace is ready to charge. If, for any reason, it is impossible to pour the metal immediately, the charge may be held in the furnace without danger of overheating, since no part of the furnace structure is appreciably hotter than the metal. If desired, rocking may be continued during this period, in order to insure a perfectly uniform temperature and a thorough mixture of the alloying metals.

The indirect arc lends itself excellently to the maintenance of a uniform power input and a steady electrical load. After a little experience the operator learns to judge from the kilowatt-hour input, how to adjust the rocking of the furnace and when the metal is hot enough to pour. In other words, he knows what condition the metal is in by observing from his meter how many kilowatt-hours of heat he has put into the furnace. This is the most convenient and satisfactory method of controlling the temperature, as well as the heat input, and works extremely well, even with an operator of very mediocre intelligence.

The reliability of the furnace is high, since its construction is both simple and rugged. Its cylindrical form permits the strongest possible refractory structure; the method of heat generation is simple and involves no complicated parts, electrical or otherwise; the gears and other parts of the rocking mechanism are sturdy and not exposed to high temperatures, while the electrical control mechanism is as simple as it can be made and very seldom a source of trouble. There is nothing complicated about the controls and even the greenest of operators rapidly becomes proficient in their use.

The power imput of the furnace is relatively large and its thermal efficiency high, this desirable combination resulting in a high productive capacity. The arc is not more than ten inches from the metal on a full charge, while it is approximately eighteen inches distant from the nearest refractories—the vertical and walls—and 20 inches from the cylindrical walls. This makes possible a rapid rate of heating without injury to the refractories, while overheating of the surface layer of the metal nearest to the arc is prevented by the constant mixing which it undergoes. Using 2000 lb. charges, the rocking furnace will produce approximately 2000 lb. of molten brass per hour, melting time, or about 1500 lb. per hour, elapsed time, the latter including time consumed in charging, pouring, and incidental delays. This is a higher productive capacity than can be obtained with any other electrical brass-melting furnace of similar size.

The quality of the metal produced is a function of temperature control, thorough mixing, and the absence of impurities. Any electric furnace which does not burn the metal makes possible the avoidance of impurities and thus compare favorably with fuel-fired furnaces, which expose the metal to a rapidly moving oxidizing atmosphere which also contains sulphur and other undesirable products of combustion.

Accurate temperature control is difficult in those types of electric furnaces which heat their refractory walls and roofs far above the metal temperatures, thus causing the metal to absorb heat even after the electric curent has been turned off. In an arc furnace the heat input stops immediately when the switch is opened and metal can be held in the furnace indefinitely without danger of overheating.

In the rocking furnace a perfect mixture of the metals which go to make up the alloy can readily be attained, by virtue of the brisk agitation which the molten metal receives. Even high-lead alloys can be poured from the furnace in perfectly homogeneous mixtures. The table below shows the results obtained with a series of heats, from which samples were taken of the first ingot from the first ladle and the last ingot from the last ladle in each case. The variation in composition from heat to heat was due to the selective absorption of lead by a green furnace lining. While the variation in lead content between the first and last ingots of any heat is very small it will be noted that, in three cases out of four, the percentage of lead in the first ingot is higher than that in the last.

TABLE I.

Heat No.	Ladle No.	Per Cent Cu	Per Cent Sn	Per Cent Sb	Per Cent Pb	Per Cent Zn Plus Impurities
1	First	72.73	4.97	0.61	21.02	0.67
1	Last	72.12	4.88	0.61	20.97	1.42
2	First	68.89	4.86	0.61	23.19	2.45
2	Last	69.09	4.47	0.61	22.96	2.87
3	First	66.51	4.24	0.61	25.49	3.15
3	Last	67.15	4.30	0.61	25.28	2.66
4	First	67.07	4.30	0.61	25.02	3.00
4	Last	66.01	4.47	0.61	25.67	3.04

It is, of course, frequently very important to duplicate a complex alloy, for heat after heat, with a minimum deviation from the specified composition. Table II shows how exactly this can be done with the rocking furnace. The figures given in the table are taken, not from a special test, but from the routine analysis for thirteen consecutive heats from a rocking furnace melting phosphor bronze.

TABLE II.

Heat No.	Per Cent Cu	Per Cent Sn	Per Cent Pb	Per Cent Zn	Per Cent P
45	86.90	8.35	1.63	3.04	0.015
46	87.18	8.43	1.09	3.28	0.020
47	86.68	8.37	1.37	3.56	0.020
48	87.24	8.36	1.26	3.10	0.020
49	86.84	8.20	1.21	3.73	0.014
50	86.94	8.10	1.04	3.91	0.014
52	87.80	7.64	1.36	3.20	0.020
53	87.16	8.27	1.30	3.26	0.014
54	86.96	8.27	1.33	3.43	0.010
55	96.82	7.98	1.21	3.96	0.025
56	87.20	8.27	1.25	3.27	0.014
57	87.12	8.27	1.23	3.36	0.016
58	86.80	8.59	1.21	3.39	0.013
Average	87.05	8.24	1.27	3.42	0.017
Max. deviation from average...	0.75	0.60	0.36	0.54	0.008
Average deviation from average...	0.22	0.26	0.10	0.23	0.004

The thermal efficiency of the rocking furnace is high, and the energy consumption per ton of metal melted is correspondingly low. The thermal efficiency of the furnace is considerably higher than that of any stationary type of indirect-arc furnace, even higher than that of the direct-arc furnace. It is more nearly comparable to the efficiency of the induction furnace which, since the source of its heat is in the resistance of the metal itself, does not heat its refractories to a temperature higher than that of the metal and consequently enjoys the advantage of minimum radiation losses, as well as an utter absence of electrode heat losses. The high efficiency of the rocking furnace is primarily due to the fact that approximately four-fifths of the inner refractory lining is washed by molten metal, due to the rocking action of the furnace. Most of that part of the lining which is exposed to direct radiation of heat from the arc, and thereby becomes hotter than the metal, is intermittently brought into contact with the latter and gives up its excess heat to the metal instead of expending it uselessly through the outer walls. The furnace refractories are thus subjected to a constant cooling action and are maintained at a relatively low temperature, with the result that radiation losses are a minimum, appreciably lower than would be the case if the furnace were operated in a stationary position.

The comparatively low refractory temperature in the rocking furnace makes it possible to obtain a high thermal efficiency without an excessive thickness of heat-insulating wall. As a result, the temperature lag of the furnace is moderate and, when operating from 8 to 10 hours per day, the furnace reaches its maximum efficiency on the third heat of the day, an important consideration in intermittent electric furnace operation.

The number of kilowatt hours required per ton of metal varies widely, depending upon operating conditions and upon the nature of the alloy melted. One large rolling mill, operating the furnace 16 hours per day of 60-40 brass, gets a minimum consumption of less than 200 kw.-hrs. per ton and has averaged 224 kw.-hrs. over a total of several hundred heats. Average 8 to 10 hour operation on clean scrap and new metal mixture shows about 250 kw.-hrs. for yellow alloys, and 275 kw.-hrs. for red alloys. If a high proportion —over 50 per cent—of very oily or wet borings and grindings are included in the charge, the energy consumption on 2000 lb. charges may run as high as 300 kw.-hrs. per ton.

The ability to handle very dirty borings and fine scrap of all kinds, whether red or yellow, is an advantage peculiar to the rocking furnace. It is possible in this furnace to melt satisfactorily a charge consisting wholly of dirty yellow borings and grindings, without opening the furnace after melting begins, something which can hardly be done in any other furnace without mechanical rabbling accompanied by high metal loss.

Although as already mentioned, the labor cost per furnace-day with furnaces of similar size does not vary greatly from one electric furnace to another, the high productive capacity of the rocking furnace makes possible a very low labor cost per ton of metal melted.

The importance of the metal saving effected by any properly designed and correctly operated electric furnace is well recognized. In the rocking furnace clean yellow brass can be melted with a net loss below one per cent. With red mixtures the net loss is, of course, less than with yellow metal, usually not above 0.5 per cent. Borings and fine dirty scrap can be melted with far less loss than is the case in any type of fuel-fired furnace, or in any type of electric furnace where mechanical rabbling is necessary, although the loss is, of course, higher than with clean scrap or new metal mixtures. Metal losses under two per cent when melting very dirty borings and cuttings are by no means unusual, this with metal which must ordinarily be melted in a reverberatory furnace, with complete loss of the volatile constituents of the alloy. Red borings, if not too dirty, can be melted with a loss practically as low as that experienced with clean red scrap or new metal.

The rocking furnace has introduced one decided innovation in brass foundry practice. With this furnace it is not only possible, but even highly desirable, to add spelter with the rest of the charge at the beginning of the heat, when melting new metal or making up a deficiency of zinc in a scrap charge. This not only saves the time ordinarily consumed by the speltering operation but also avoids the necessity of opening the furnace for this purpose, with the attendant loss of metal and heat. Tin and lead should also be added with the rest of the charge rather than at the end of the heat.

The excellent showing made by the rocking furnace, as compared with other types of arc furnaces, with respect to metal loss, is due to the rocking motion of the furnace, with the resultant agitation of the metal which eliminates all danger of local overheating of the charge.

The rocking feature of the furnace also plays an important part in prolonging the useful life of the refractory furnace lining. The continual washing to which most of the lining is subjected cools the refractories to a temperature only slightly above that of the metal itself, well below the critical temperature of the refractory brick used. The brick selected for this service is of such a nature that erosion by the constantly moving metal is not a serious factor. A single lining of corundite brick lasts for about 350 heats in average practice, at which time it requires more or less extensive patching. Under normal conditions it is never necessary to entirely replace this inner lining, while the intermediate and outer linings ordinarily require no attention. One user of the furnace reports having obtained 600 heats from his first lining, on intermittent operation, and states that he expects to obtain from 900 to 1100 heats on continuous operation. Under average conditions the refractory cost is less than $0.50 per ton of metal melted.

The electrode consumption is from 2 to 3 lb. per ton of metal melted, or, at present prices, from $0.50 to $0.75 per ton of metal. This compares very favorably with the best arc furnace practice in such installations as use the stationary type of arc furnace for melting copper alloys.

The overhead cost of melting with the rocking furnace is low, particularly in such installations as take full advantage of its inherently high productive capacity. The first cost of any electric furnace is rather high and the canny user will see to it that the furnace is busy melting metal for as many hours in each day as his manufacturing schedule will permit.

One more point which is of particular interest for the central-station company and others who supply power for electric furnace use: The electrical characteristics of the rocking furnace are such as to cause the furnace to be considered a highly desirable power load. As compared with arc furnaces in use for steel melting, its demand is exceptionally steady and free from violent fluctuations, while its average power factor is from 85 to 95 per cent. Its maximum demand is less than 300 kw. and the load which it imposes on the power line is so steady as to result in little or no inconvenience to the average central-station company or to those of its customers who may take power from the same line.

Cohune Nut Industry

In the search for materials suitable for the manufacture of gas-mask charcoal, the War Department found that the cohune (or corozo) nut, which yields a charcoal of high absorptive power, could be obtained in large quantities from Hondures. It was also discovered that the kernel of this nut contains an oil which is said to be superior to cocoanut oil and finds a ready sale as a high-grade cooking oil.

Attention is directed in Commerce Reports, June 6, 1919, p. 1230, to the fact that the extensive field of these nut-bearing trees found in the Aguan River Valley in Honduras is capable of yielding 10,000 tons of nuts a month, with a working force of 500 men.

It must be remembered that, if we desire to secure a permanent market for our products in South and Central America, we must, in turn, endeavor to utilize more of the raw materials which these countries have to offer and thus aid in the development of their natural resources.

Imports and Exports

The Bureau of Foreign and Domestic Commerce of the Department of Commerce, reports for April, 1919.

IMPORTS OF GLYCERIN (TOTALS) INTO U. S. AND DOMESTIC EXPORTS FROM U. S. BY COUNTRIES

Imports

	Lb.	Value
Glycerin	34,345	$3,749

Exports of Glycerin

Countries:	Lb.	Value
Greece	425	$219
Norway	1,120	250
Portugal	500	113
Spain	2,200	550
British Honduras	5	2
Canada	1,781	319
Costa Rica	700	175
Guatemala	961	482
Honduras	152	47
Nicaragua	238	103
Panama	47	29
Salvador	700	154
Mexico	3,400	837
Barbados	75	21
Jamaica	30	6
Trinidad and Tobago	150	36
Other British West Indies	7	2
Cuba	10,814	2,980
Dutch West Indies	23	11
French West Indies	7	4
Haiti	109	31
Dominican Republic	529	157
Bolivia	100	23
Brazil	3,954	867
Chile	11,139	2,994
Colombia	611	295
Ecuador	670	170
Peru	3,212	948
Venezuela	1,559	528
China	2,710	637
British India	2,404	994
Japan	186,560	31,868
New Zealand	55	23
German Oceania	10	8
Philippine Islands	650	167
Total	237,607	$46,050

DOMESTIC EXPORTS OF TIN PLATE, TERNE PLATE AND TAGGERS TIN FROM U. S. TO ALL COUNTRIES

Tin Plate, Terne Plate and Taggers Tin

Countries	Lb.	V alue
Belgium	166,667	$21,205
Denmark	168,760	19,605
Greece	3,920	400
Iceland and Faroe Islands	5,350	430
Norway	662,630	50,451
Portugal	671,392	67,022
Spain	373,988	37,927
Sweden	480,524	38,257
Switzerland	461,820	48,330
Canada	9,496,288	709,301
Guatemala	6,196	587
Panama	22,174	1,581
Salvador	9,000	900
Mexico	1,234,445	96,216
Jamaica	22,456	1,835
Trinidad and Tobago	10,423	940
Cuba	216,623	21,175
French West Indies	10,315	900
Haiti	2,000	170
Dominican Republic	1,996	155
Argentina	4,727,265	425,149
Brazil	3,656,751	295,225
Chile	59,574	5,309
Colombia	6,493	707
Ecuador	5,500	600
British Guiana	1,675	205
Paraguay	91,014	7,336
Peru	210,582	14,688
Uruguay	2,782,186	236,634
Venezuela	76,254	5,809
China	861,521	94,944
Japanese China	78,483	6,560
British India	1,059,180	84,361
Dutch East Indies	160,000	16,000
Hong Kong	176,000	17,780
Japan	4,063,942	372,823
Turkey in Asia	682,800	48,514
New Zealand	50,318	2,472
Philippine Islands	8,250	610
British West Africa	2,140	162
Total	32,786,895	$2,753,275

IMPORTS OF TUNGSTEN-BEARING ORE INTO U. S. FROM ALL COUNTRIES—EXPORTS OF TUNGSTEN AND FERROTUNGSTEN METAL FROM U. S. TO ALL COUNTRIES

Imports

Countries	Tungsten-Bearing Ore Tons	Value
Canada	18	$12,750
Chile	35	48,121
Peru	56	40,669
China	25	11,474
Kong Kong	180	192,899
Total	314	$305,913

Exports

Countries	Tungsten and Ferrotungsten Lb.	Value
Sweden	3,300	$5,250
Canada	2,065	2,686
Total	5,365	$7,936

IMPORTS OF TIN BARS, BLOCKS, PIGS OR GRAIN OR GRANULATED INTO U. S. BY COUNTRIES AND DISTRICTS—TOTAL IMPORTS OF TIN ORE

	Tons	Value
Tin ore	534	$311,467

TIN BARS, BLOCKS, PIGS, GRAIN OR GRANULATED

Districts:	Lb.	Value
Massachusetts	112,040	$77,220
New York	56,000	42,641
Pittsburgh	56,000	44,114
San Francisco	1,026	650
Washington	55,716	$37,435
Chicago	224,121	135,141
Total	504,903	$337,201

Countries:	Lb.	Value
Straits Settlements	504,903	$337,201

The Present Status of Labor in the English Chemical Industry

BY A. E. MARSHALL

IN PRE-WAR days in England, labor costs in the production of any of the staple chemicals were not the subject of very careful consideration by factory managers. Labor was plentiful and cheap, and as a result of the continuous excess supply, labor invariably, under the stimulus of retaining its hold on a job, was efficient.

All this has changed, and today the most important item in costs is labor. Very little attention had been paid, prior to 1914, to the use of labor-saving devices, and the plants were of such design that many of the standard forms of mechanical equipment, such as find use in the American industry, could not be utilized.

Factories erected during the war have had incorporated in their design a considerable amount of mechanical equipment, but in most cases these factories are not readily capable of change from specialized war products to staple chemicals, so that factory equipment as a whole is little in advance of pre-war conditions.

As a direct outcome of the discovery during the war of the power it possessed, labor has changed its former subservient relationship to capital, as represented by the factory owners, and at this present time it has apparent control of the industries. Hours have been shortened, rates of pay have been greatly increased, and the men no longer feel that there is any necessity of doing a real day's work. It takes more men to perform a given operation now than it did in pre-war times, and as rates are up at least 120 per cent, the resulting increase in cost of production can be imagined. One manufacturer told me that whereas his labor cost on a certain product was 11c. per 100 lb. before the war, it was now in excess of 30c., and likely to go even a shade higher.

There is a feeling of unrest in the factories which is not confined to the workmen, but extends to the salaried staffs, who have always before them the contrast of inefficient labor paid at high rates, and their own high living costs, high income tax rates, and only slightly increased salaries. As an instance of the general complaint in this direction, recent papers carried letters from a Judge and a Bishop, each presenting a budget of his expenses, and each proving rather conclusively that he could not make both ends meet without a substantial change in his pre-war salary.

Labor in the chemical industry was not organized before the war, as the only attempt to form a union (in 1895) failed through lack of support. Now there is a fairly strong union body, with about 40,000 members, affiliated with the National Federation of General Workers. A ballot is to be taken shortly by this union on the question of handing in notices to enforce 12 hours pay for 8-hour shifts with a 44-hour week, and there does not seem to be much doubt as to the result being in favor of the strike notices. So the path of the manufacturer seems to have difficulties present and ahead.

One totally unexpected feature is the disappearance of women from the industry. While the war was in progress, the English newspapers which reached America carried column after column about women who had found a niche in industry. Every trade opened its formerly closed gates to the woman worker, and by general consent women were conceded a permanent place in the industrial world. And now, before even demobilization is complete, women's hold on the industries has slipped, and without an apparent struggle the woman worker has been dispossessed and a man has her place. There are of course minor exceptions, but in the factories which were staffed by men in the pre-war days, women have done their day and service and are already passing into a remembrance. One friend, showing me through his plant, said: "I had over 200 women in this department from late '15 to early this year—but now I haven't one." He had no explanation as to why or where his women workers had gone, and he had too many other troubles to waste time on any abstruse speculations, the simple fact being that they had gone.

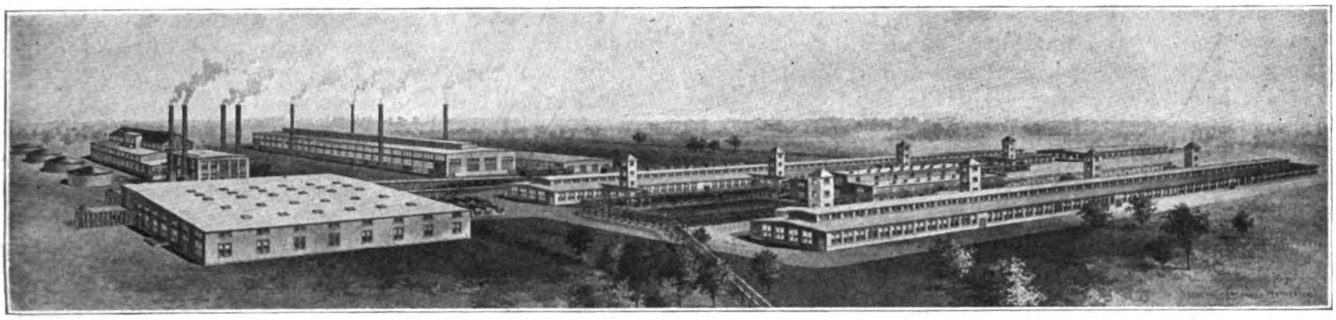
Another factory I have just visited was busy during the war in the manufacture of scientific apparatus. I had heard of this factory as an example of the development of women workers to a high state of efficiency, but I found only four women left, and men, incompetent because of inexperience, turning out work that was obviously crude.

So one of the questions which agitated England during the war, "What shall be done with women in the industries?" has quietly solved itself, and it is well within the bounds of past experience for the present labor difficulties to adjust themselves and disappear. A thoughtful labor man with a wide acquaintance among the labor leaders in various industries said in the course of conversation: "The workingman has every present intention of getting more pay for less work, and this is the direct result of the extravagant expenditures of the war profiteers, but the only solution I can see to the coming industrial crisis is increased work during the shorter hours our members have already secured."

Four years of war, four years of tense production, have brought in their train an inevitable slackness among the workers due to the removal of the stimulus, and just like a case of bodily overstrain, the recovery will have to be by gradual stages. Herein lies one of the dangers to the English chemical manufacturer. The change in the relationship between capital and labor has made his position indeed unenviable, as while the present high ocean freights protect his home market they prevent him from entering his high-labor-cost products into export competition.

Chemical manufacturers generally express their present fears of American competition in the export trade, and in the domestic trade as soon as transatlantic freights drop from their present high levels. There is a definite trend observable, even in the most casual talks with manufacturers, toward protective tariffs, and it seems certain that attempts will be made to preserve the domestic trade to English chemical manufacturers by the adoption of some form of protection.

London, England.



The United States Government Chlorine-Caustic Soda Plant at Edgewood Arsenal, Edgewood, Maryland

The Largest Chlorine Plant in the World—History of the Design, Building and Operation—Brine Purification Plant—Cell Installation, Concentration and Fusion Department—Chlorine Drier and Equipment—Caustic Soda

By SAMUEL M. GREEN

SOON after the declaration of war against Germany, the War Department decided upon a very extensive poison-gas offense program. After much study of this comparatively new method of warfare, it was decided to build a Government plant for the purpose of manufacturing poison gases of all varieties and for filling the gas shells, bombs, hand grenades, etc.

Chlorine is the base from which practically every gas is made which is used in warfare. The War Department evidently expected to secure the required amount of chlorine gas from private plants, but as the gas program developed it became evident that the supply from such sources would be inadequate. The construction of the Government plant for the manufacture of poison gas, known as Edgewood Arsenal, was started in the fall of 1917. This arsenal is located about twenty miles north of Baltimore, Md., on Government property.

Manufacturers of electrolytic chlorine cells were requested late in December, 1917, to submit bids for the building of chlorine plants with capacities of from 15 to 200 tons. It was finally decided to build a plant having a capacity of 100 tons of chlorine gas per 24 hours, locating it at Edgewood Arsenal.

On March 3, 1918, the Procurement Division awarded a contract to the Warner Chemical Co. of New York, which owns the Nelson electrolytic chlorine-caustic soda patents[1], provided that it should furnish the United States Government 1776 Nelson 1000-ampere electrolytic chlorine-caustic soda cell units complete f.o.b. point of manufacture, having a guaranteed capacity of 50 tons of chlorine per 24 hours; that it furnish through the Samuel M. Green Co., engineers, of Springfield, Mass., complete plans and specifications for the buildings for the boilers, evaporators, Nelson cells, salt storage and preparation, caustic soda fusion, weak caustic storage, general stores and administration; complete specifications and plans for all auxiliary apparatus and piping, the buildings and auxiliary apparatus to be designed for a capacity of 100 tons of chlorine per day; that the company should arrange for supervision of construction of buildings and installation of apparatus by the officials of the Samuel M. Green Co. and for the general supervision of the starting and operation of the plant by H. R. Nelson, inventor of the Nelson cell, and Samuel M. Green, president of the Samuel M. Green Co., until such time as all guarantees had been fulfilled and the plant was being successfully operated by the Government officials.

The contract required that one-quarter of the total number of cells should be shipped on June, July, August and September 7, and that shipments should be anticipated as much as possible, the Government agreeing to provide for the installation of the cells as and when received.

In order that at least a small experienced force of men should have the necessary knowledge for installing and operating the plant, the Government agreed to furnish enlisted men who were to be sent at Government expense to the plant of the Warner-Klipstein Chemical Co., located at Charleston, W. Va., operator of a large Nelson cell plant, the Warner Chemical Co. agreeing that these men should be given every facility to acquire the special knowledge required for operating such a plant.

This arrangement solved the most difficult problem facing the engineers: i.e., an experienced operating organization. Its successful solution was largely due to the enthusiasm and splendid work of the officers and men who were sent to Charleston and to their untiring work at Edgewood during the installation and starting of the plant.

No definite action was taken by the Government in regard to the second 50-ton chlorine cell plant until about April 5, when Col. William H. Walker, commanding officer of Edgewood Arsenal, informed the engineers that it had been definitely decided to proceed with its installation. The award for the additional cells was placed with the Warner Chemical Co. on June 15, and this contract called for the delivery of one-quarter of the total number of 1776 cells on Nov. 1, 1918; Dec. 1, 1918; Jan. 1, 1919, and Feb. 1, 1919.

The entire number of cells called for by the first contract were delivered and erected ready for operation by Sept. 1, and the entire number of cells called for by the second contract were delivered and more than one-half of them were erected before the signing of the armistice.

---

[1] U. S. Patents 929,469; 1,149,210 and 1,149,211.

Under the contract, it devolved upon H. R. Nelson and Samuel M. Green to devote practically their entire time to this project, for they were made entirely responsible for the design of the plant, supervision of its building and installation and its subsequent operation.

The Foundation Co. of New York was awarded the contract for building the chlorine plant in accordance with the plans and specifications and under the supervision of the engineers.

Lieut. Col. E. B. Ellicott, representing the Construction Division of the War Department, was placed in charge of the work, and to his great ability and untiring effort the success of the undertaking was largely due. The Construction Division in Washington drew off all quantities from the plans and purchased the materials.

Considering that it was almost impossible to secure labor in adequate quantity or quality; that it was constantly changing; the difficulties incident to divided authority between two organizations—one responsible for purchase and the other for the erection of materials; and other difficulties of those most strenuous times, the rapidity of the construction of this plant reflects great credit upon the Foundation Co.

The auxiliary apparatus for the plant was purchased under the direction of Col. Charles N. Black upon specifications furnished by the engineers. The purchase and control of the delivery of this apparatus was finally placed under the direction of the main office of Edgewood Arsenal, located at Baltimore, Md.

During the fall and winter of 1917 and 1918, work was in progress at Edgewood Arsenal on the buildings for the chemical plant for the manufacture of toxic gases, for the filling of gas shells, and housing for officers and men. On March 5, 1918, it was decided to locate the chlorine plant near the chemical plant then in process of construction, and plans of the general arrangement of the buildings were immediately made. On March 27, however, it was decided to place the chlorine plant about 1800 ft. from the chemical plant.

ELECTRICAL INSTALLATION

Sargent & Lundy, engineers, of Chicago, Ill., designed and supervised the installation of the electrical equipment for supplying direct current to the electrolytic cells.

The Government entered into a contract with the Pennsylvania Water & Power Co. to supply 20,000 kw. at 60,000 volts over a high tension transmission line ten miles long. A 20,000-kw. steam power plant was also built on Bush River to act as a reserve, but it was not completed before the signing of the armistice. Current was supplied to the cells from a rotary converter installation located between the cell buildings.

The generating apparatus consisted of the necessary transformers, switching arrangements and twenty-four 2000-amp. and two 4000-amp., 300-volt rotary converters of the booster type. Each 2000-amp. rotary converter supplied current to two cell circuits, each circuit containing 74 cell units. The 4000-amp. rotaries were

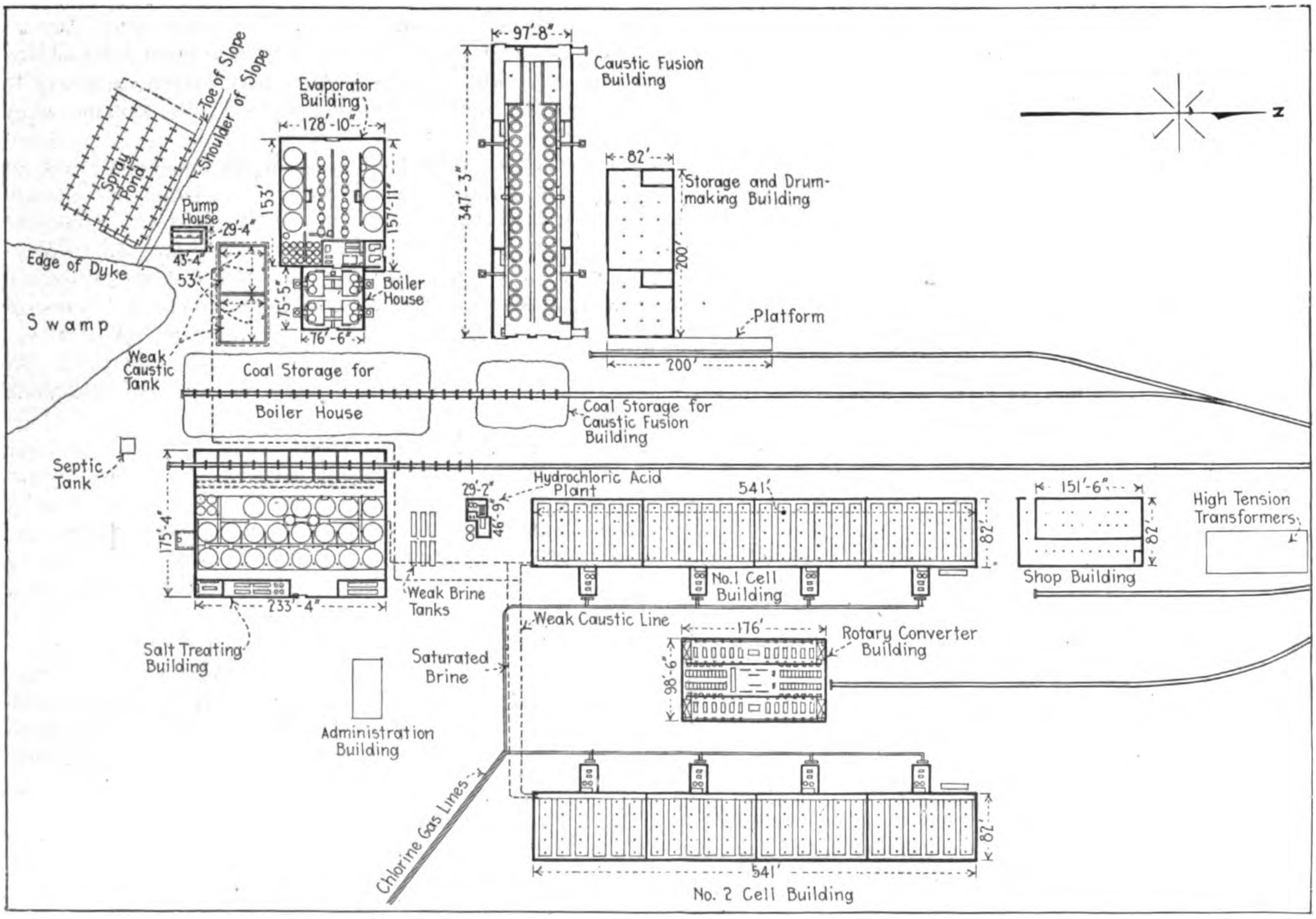

Toe of Slope
Shoulder of Slope
Spray Pond
Evaporator Building
128'-10"
153'
157'-11"
Pump House
29'-4"
43'-4"
53'
Edge of Dyke
Swamp
75'-5"
76'-6"
Boiler House
97'-8"
347'-3"
Caustic Fusion Building
82'
Storage and Drum-making Building
200'
Platform
200'
Z
Weak Caustic Tank
Coal Storage for Boiler House
Coal Storage for Caustic Fusion Building
Septic Tank
175'-4"
233'-4"
Salt Treating Building
Weak Brine Tanks
29'-2"
46'-9"
Hydrochloric Acid Plant
541'
82'
No. 1 Cell Building
151'-6"
82'
Shop Building
High Tension Transformers
Weak Caustic Line
176'
98'-6"
Rotary Converter Building
Saturated Brine
Administration Building
Chlorine Gas Lines
82'
541'
No. 2 Cell Building

FIG. 1. GROUND PLAN OF THE CHLORINE-CAUSTIC SODA PLANT

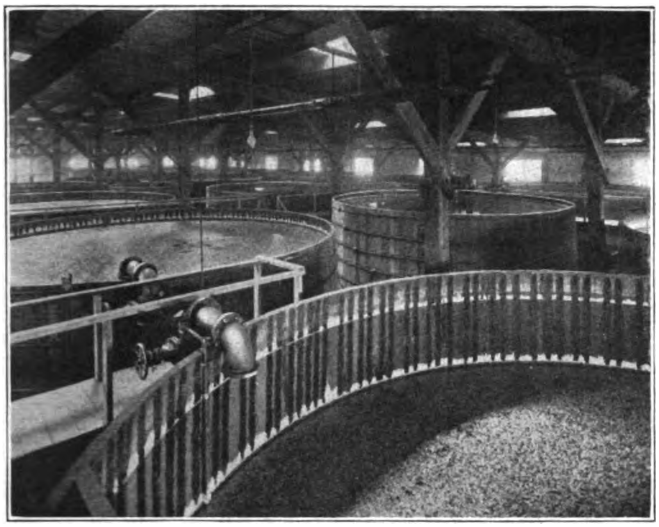


FIG. 2. BRINE PURIFICATION TANKS

to be used as spare units and were purchased because they could be secured before the 2000-amp. units could be obtained. The maximum direct current required to operate the 3552 cell units would have been somewhat less than 14,000 kw. when the plant was producing 100 tons of chlorine gas per 24 hours.

The electrical current for the operation of the auxiliary apparatus and for lighting the plant was supplied from a power plant located near the filling and chemical plant. This power plant supplied current at 60 cycle and it was considered advisable to use this, as the current from the Public Service system was 25 cycle and it was found impossible to secure standard motors at this frequency within a reasonable time.

General Arrangement

The chlorine plant buildings, a ground plan of which is shown in Fig. 1, consisted of a salt storage and treating building, two cell buildings, a rotary converter building, a building for machine shop and general stores, a high tension transformer yard, a boiler, power and evaporator building, weak caustic liquor storage tanks, a water pumping building and spray cooling pond, a caustic fusion building, and a drum making, caustic cooling and shipping building.

In connection with the chlorine plant, there was also constructed a liquefying plant for chlorine, a sulphur chloride making and sulphur distilling plant. This equipment was located about 1800 ft. from the chlorine plant and near the chemical plant.

Salt Storage and Treating Building

The salt storage and treating building, Fig. 2, was located on ground much below the cell building's elevation and allowing the railroad to enter the building on the top of the salt storage tanks. These tanks were constructed of concrete. There were seven of these tanks, each 34 ft. long, 28 ft. wide and 20 ft. deep, having a capacity for storing 4000 tons of salt. There would have been 200 tons of salt used per day when the plant was running at full capacity. The salt was shoveled directly from the cars into these bins, an automatic grain shovel being provided for this purpose.

On the bottom of each tank distributing pipes for dissolving water supply were installed, and at the top of each, at the end next to the building, there was an overflow trough and skimmer board arranged so that the dissolving water, after flowing up through the salt, overflowed into this trough and then into a piping system and into either of two collecting tanks.

The piping system for delivering dissolving water to the storage tanks and for collecting the brine from the tanks was arranged so that dissolving water could be delivered to any tank, returned to one of the collecting tanks, and then be delivered to another storage tank and back to the second collecting tank. This arrangement was made so that all of the salt in any storage tank could be dissolved, and if the brine was not fully saturated it could be passed through another storage tank containing a deep body of salt and thereby be fully saturated. The saturated brine was pumped from the collecting tanks to any one of 24 treating tanks. Each of these tanks had a capacity of 72,000 gallons.

The eighth concrete storage bin was used for the storage of soda ash used in treating the saturated brine. Soda ash was delivered from the cars into this bin and was delivered from the bin on the floor level of the salt building to the soda ash dissolving tanks. From these tanks, the solution was pumped in desired quantity to any one of the 24 treating tanks. After the

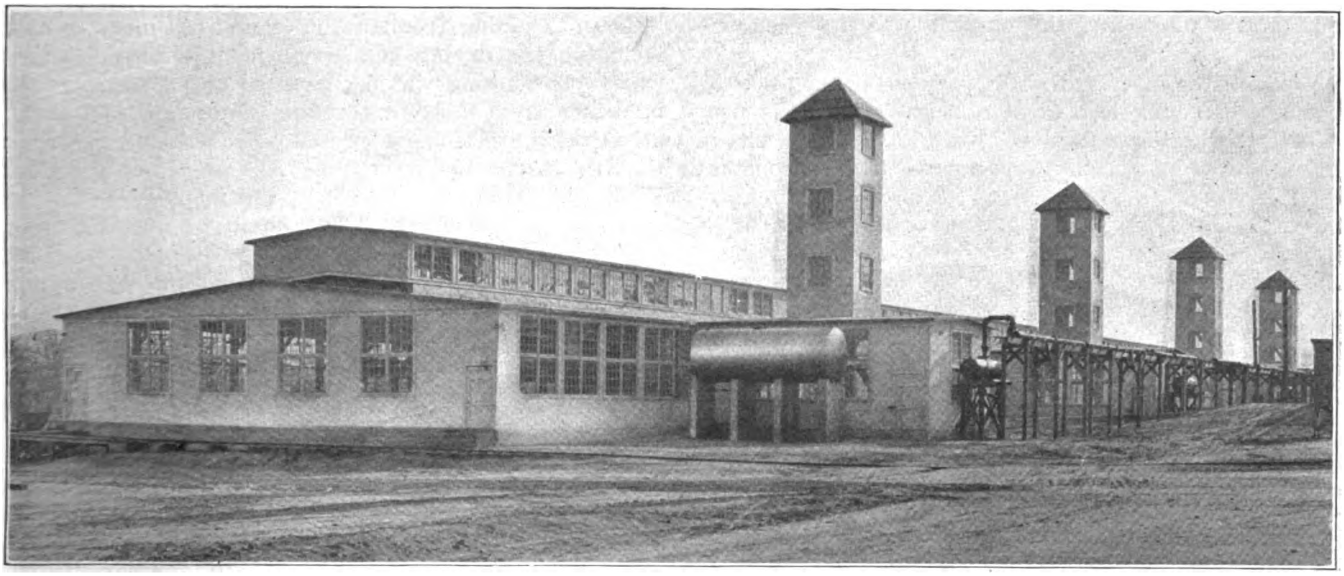


FIG. 3. CHLORINE CELL BUILDING DRYING TOWERS AND PIPE LINE

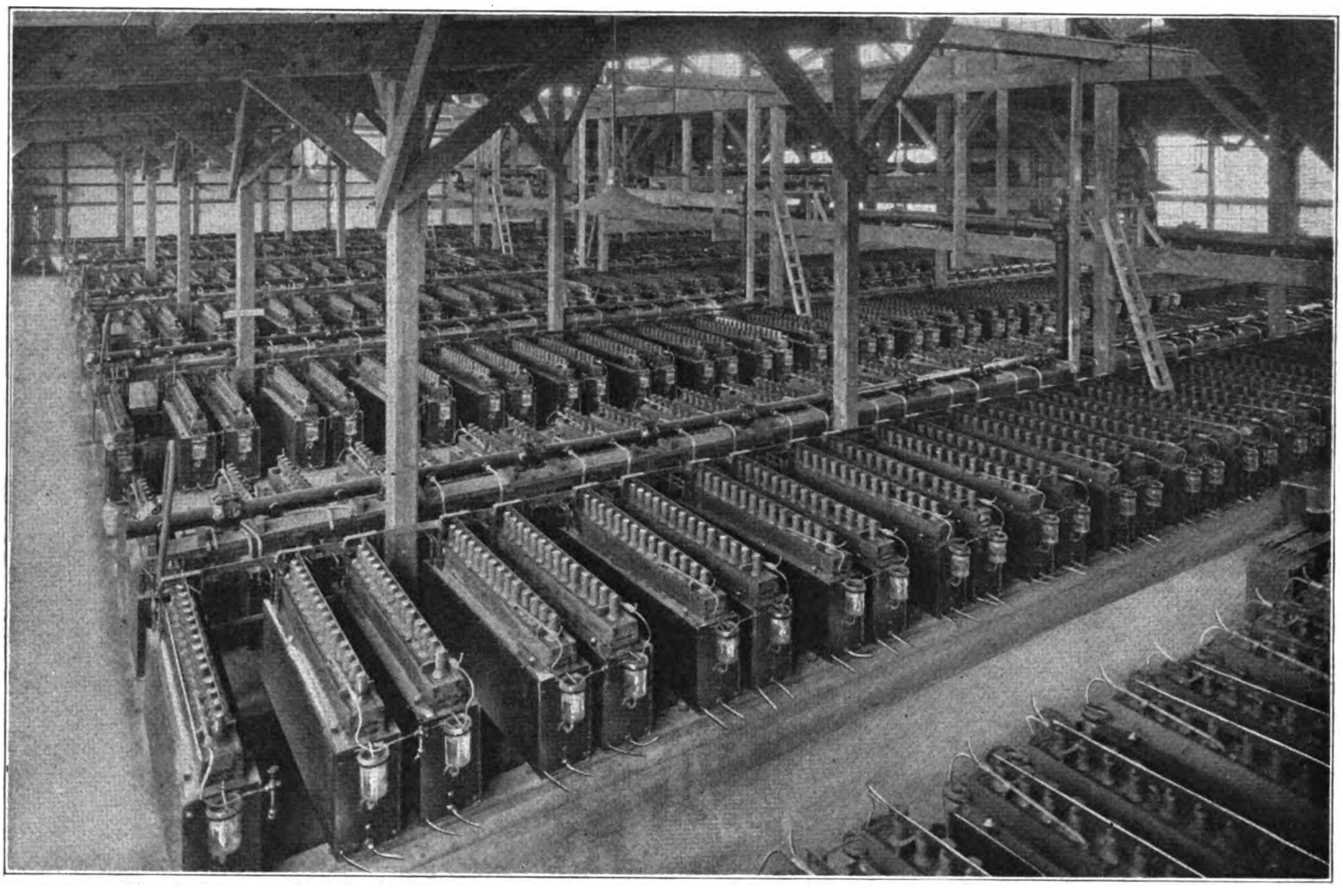


FIG. 4. CELL ROOM, SIX BANKS OF 74 CELLS EACH

brine was treated and settled, the clear, saturated brine was drawn from the treating tanks through decanting pipes and delivered by pumps to any one of four neutralizing tanks.

These tanks were located next to a platform on the level of the car body, above the top of the salt storage bins, and hydrochloric acid was delivered directly from the cars to this platform, providing a large storage capacity for this acid. The platform level was about 30 in. below the level of the top of the neutralizing tanks and the acid was easily dumped into the tanks from the carboys. It was at first expected that the acid would be purchased, but it was finally decided to make it by the use of chlorine and hydrogen from the cells, and a plant for this purpose was designed and erected.

The neutralized brine was delivered from the tanks by a pump to a tank located at a height above the floor so that the brine would flow by gravity to the cells in the cell buildings. This tank was kept at a constant level by use of float valves and gave a constant hydraulic head to the cell feeding devices. The floor of the salt building was of concrete provided with open drains leading into a large concrete sump. Any leakage of brine was thus collected and returned to the system. The entire tank equipment was of wood and was purchased from and erected by the John Eppler Co., Baltimore, Md. The work was carried out in a most excellent manner, as is evidenced by the fact that there was practically no leakage. There was a chemical laboratory in one corner of the building for the chemical control of the brine. Two acid tanks were installed in this building, into which the weak sulphuric acid from the chlorine gas drying equipment in the cell buildings flowed by gravity. As these tanks filled, they were emptied into tank cars on the track above the salt storage tanks, and these cars delivered the acid to an acid drying plant located near the chemical plant. The acid after being dried was returned to the cell buildings for re-use.

ELECTROLYTIC CELL BUILDINGS

There are two cell buildings, each 541 ft. long by 82 ft. wide and separated by partitions into four sections containing six cell circuits of 74 cell units. Each section is a complete unit in itself, provided with separate gas pump, drying and cooling equipment, and has a guaranteed capacity of 12.5 tons of chlorine gas per 24 hours.

The gas piping from the individual cell units to and including the drying equipment is of chemical stoneware. The piping was designed so that the gas could be drawn from the cells through the drying equipment at as near atmospheric pressure as possible in order that the gas could be kept as free of air as possible. When operating, the suction at the pump was kept at $\frac{1}{20}$ in. or less of water. The quality of the gas was guaranteed under the contract to contain at least 95 per cent Cl, and during the operation it was maintained at 98.5 to 99 per cent. The gas cooler design is shown in Fig. 5. These coolers were very effective the gas being cooled to within 1 deg. of the temperatrue of the cooling water.

The drying apparatus consisted of a stoneware tower of special design containing a large number of plates, giving a very large acid exposure. There was practically no loss of vacuum through the drying tower and cooler. The stoneware equipment furnished by the General Ceramics Co. of New York was of the most satisfactory character. The gas pumping equipment for each section consisted of two hydro turbine pumps using sulphuric acid as the compressing medium. They were direct connected to variable speed motors. (See Fig. 6.) The acid was cooled by circulation through a double pipe cooler similar to those used in refrigerating work. The pumps were made by the Nash Engineering Co. of South Norwalk, Conn. The gas was delivered under about 5 lb. pressure into large receiving tanks located just outside the pump rooms, and from these tanks into steel pipe mains which conducted the gas to the chemical plant, a distance of about 1800 ft. Three mains were provided and connected so that one was held in reserve to be used if repairs became necessary.

Nelson Elctrolytic Cell

Each Nelson electrolytic cell* unit consists of a complete fabricated steel tank; a perforated steel diaphragm spot welded to supporting angle irons; sectionalized machined plate gas dome; fourteen pieces 2½ in. diameter, 12 in. long, and fourteen pieces of 4 x 4 x 17 in. Acheson graphite electrodes; anode supporting pins; sufficient asbestos cloth and paper for the diaphragms; copper bus bars; copper connectors from cell to cell; copper ears to connect the angle iron supports of the perforated steel diaphragm; glass insulator supports for the steel tanks; glass cells for caustic, condensation and chlorine gas discharge; hard and soft rubber tubing and rubber stoppers, bolts, nuts and washers; and automatic feed.

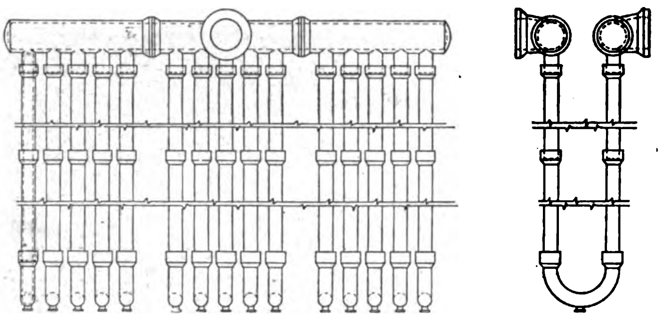


FIG. 5. GREEN STONEWARE CHLORINE COOLER

Each Nelson cell unit is guaranteed to produce 60 lb. of chlorine gas and 65 lb. of caustic soda, using not in excess of 120 lb. of NaCl (salt) per 24 hr., the gas to be at least 95 per cent pure. These guarantees were largely exceeded.

The salt solution from the cell feed tank, located in the salt treating building, flows by gravity through a piping system located in a trench running the length of each cell building, and is delivered to each cell unit through an automatic feeding device which maintains a constant liquor level in the cathode compartment.

The solution percolates from the cathode compartment through the asbestos diaphragm into the anode compartment and flows from the end of the cell, con-

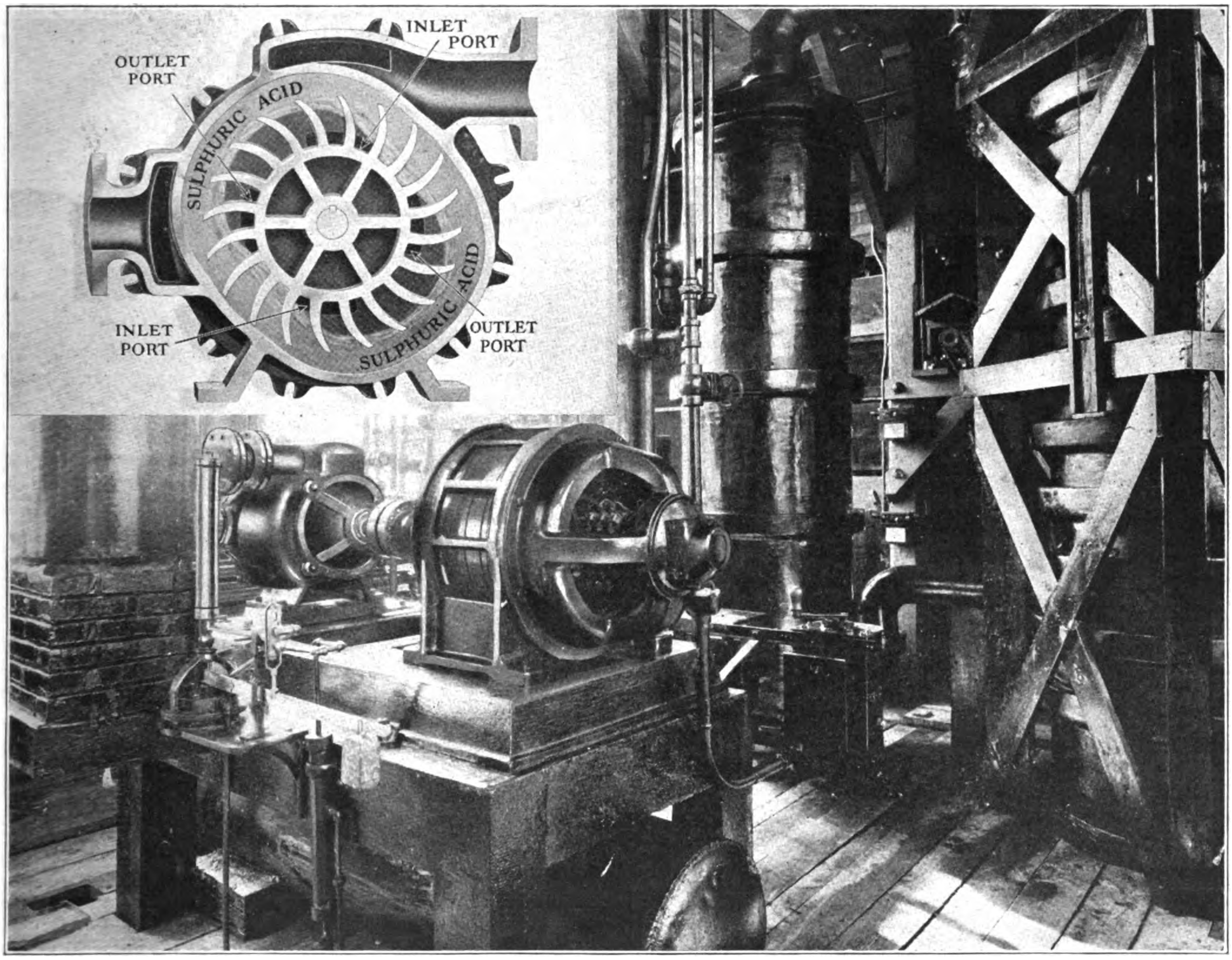


FIG. 6. HYDROTURBINE OPERATING AT EDGEWOOD ARSENAL (INSERT, CROSS-SECTION)

---

*A detailed description of the Nelson electrolytic chlorine cell will be published as a separate article in a subsequent issue.—Editor.

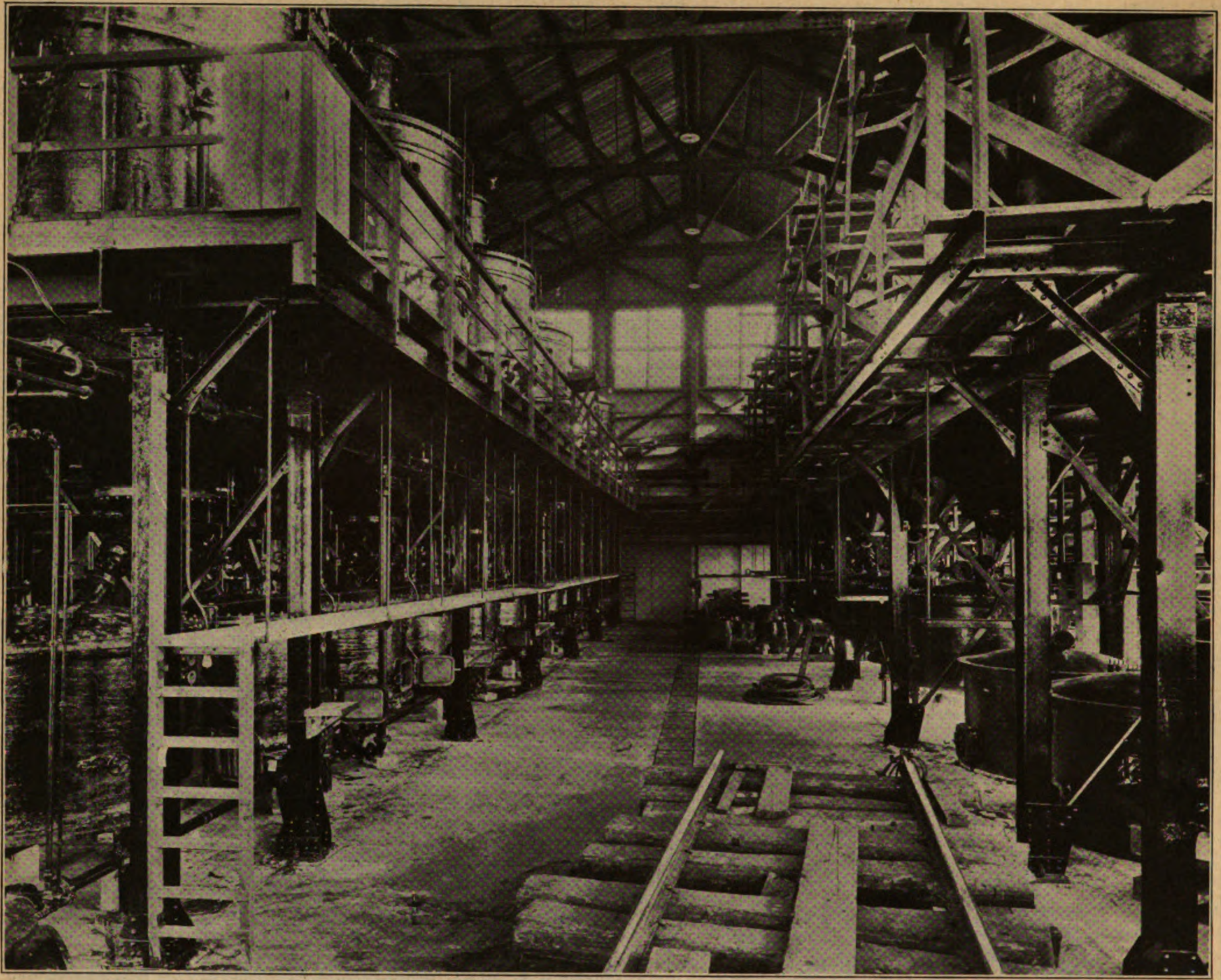


FIG. 7. EVAPORATOR BUILDING

taining from 8 per cent to 12 per cent caustic soda admixed with 16 per cent to 14 per cent salt, into an open trough and into a pipe in the trench, and through this pipe it flows by gravity to the weak caustic storage tanks located near the caustic evaporator building. These tanks were made of concrete for it was practically impossible to secure steel for tanks.

BOILER AND EVAPORATOR BUILDING

The boiler and evaporator building is on the same level as the salt treating building. Owing to natural grade of the ground, a railroad trestle was built between the salt treating building and the boiler house, and coal was dumped by gravity into this natural coal pocket.

The boiler house contained eight 500-hp. Wickes vertical water tube boilers built by the Wickes Boiler Co., Saginaw, Mich., each equipped with a mechanical stoker built by the Detroit Stoker Co. of Detroit, Mich. The boiler house was designed for a complete automatic coal and ash handling equipment, but owing to the probable temporary operation of this plant it was not considered advisable to make the investment required for this equipment. The coal was handled by a crane with a grab bucket, delivering it into a small hopper situated at such a height that coal cars operated by hand could be run under the hopper, the cars being on a level with the top of the automatic stokers. The ash was delivered into a car and pushed to an ash pile by manual labor.

In a room next to the boiler room (see Fig. 8), there was located a feed water heater, two large horizontal air compressors for furnishing air for agitating the brine and for handling acids, etc., two refrigerating machines for producing cold water to cool the chlorine gas, and two 750-kw. alternating-current steam turbo generating units.

The chemical and filling plants required a large amount of power, and it was therefore thought advisable to install steam turbines at the chlorine plant to operate in synchronism with the turbines at the chemical plant. The turbines at the chlorine plant operated with 160 lb. steam pressure and exhausted against 20 lb. back pressure, the exhaust steam being used by the caustic evaporators.

The total steam required by the evaporators would have produced about 1500 kw. per hour, and as the turbines were operated in synchronism with the large power units located at the chemical plant, the quantity of steam delivered by the turbines could be regulated to the exact amount required by the evaporators, and the power produced was at an exceedingly small fuel cost. This arrangement would have proved of great advantage, for it was found that the power provided at the chemical plant was not sufficient for the requirements and the power produced by the back pressure turbines was at very small expenditure.

CAUSTIC EVAPORATOR

The caustic evaporators were furnished by the Zaremba Co. of Buffalo, N. Y. The equipment consisted of six 108-in. double effect evaporators arranged on each side of the center of the building and under a traveling crane. Each set of six bodies was arranged to operate as three double effects and was connected to one large barometric condenser.

The water supplied for these condensers was from a cooling pond made by a natural depression in the ground outside of the evaporator building. The soil was of red clay, practically impervious to moisture, and therefore nothing had to be done to make a pond except clearing the ground of vegetation. The water from the condensers flowed by gravity to a centrifugal pump which delivered it to the spray heads, flowing from the pond back to another pump which delivered it back to the condenser. Caustic coolers were provided for cooling the caustic as it came from the evaporators.

Back of each line of evaporators there were four steel tanks of a capacity of 79,000 gal. each, for receiving the concentrated caustic liquor and storing it before it passed to the fusion building. The pumping equipment in the fusion building for handling weak and concentrated caustic liquor consisted of centrifugal pumps directly connected to motors. They were installed practically in duplicate so as to insure continuous operation.

CAUSTIC FUSION AND DRUM MAKING BUILDINGS

The caustic fusion building is located near the evaporator building and is arranged for 36 caustic fusion pots set in two rows. Thirty pots were installed.

The pot floor is about 7 ft. above the firing floor and on a level with the drum making building. Over each row of pots there are two cranes with a capacity of fifteen tons and one ton respectively. These cranes are on separate tracks, the small one being located below the large one. The large crane was for handling the pots, and the small one for handling the centrifugal pumps which were provided for emptying the fused caustic from the pots into the drums.

The drum-making building is located near the fusion building, and a railroad track comes to it with the car-floor level with the building-floor. The end of this building next to the track was provided with a brick floor and used for cooling filled caustic drums. The rest of this building was used for drum making machinery, storage of steel and drum manufacture.

Motor-operated elevating trucks were provided for handling empty and filled drums. Steel skids were provided carrying six drums each. The truck picked up these skids and transported them to the caustic pots. They were filled with caustic by the pump provided for this purpose; then they were transported to the drum making building, where they were allowed to cool while still on the steel skid. When cool, they were delivered to cars and shipped.

SULPHUR CHLORIDE PLANT

A method was devised for the manufacture of mustard gas by the use of sulphur chloride. It therefore became necessary to manufacture a large amount of this chemical. The engineers were instructed to design a plant for the manufacture of sulphur chloride and the method devised by Mr. H. R. Nelson was used. The design of this plant was started about June 15 and the plant was put in successful operation September 1, 1919.

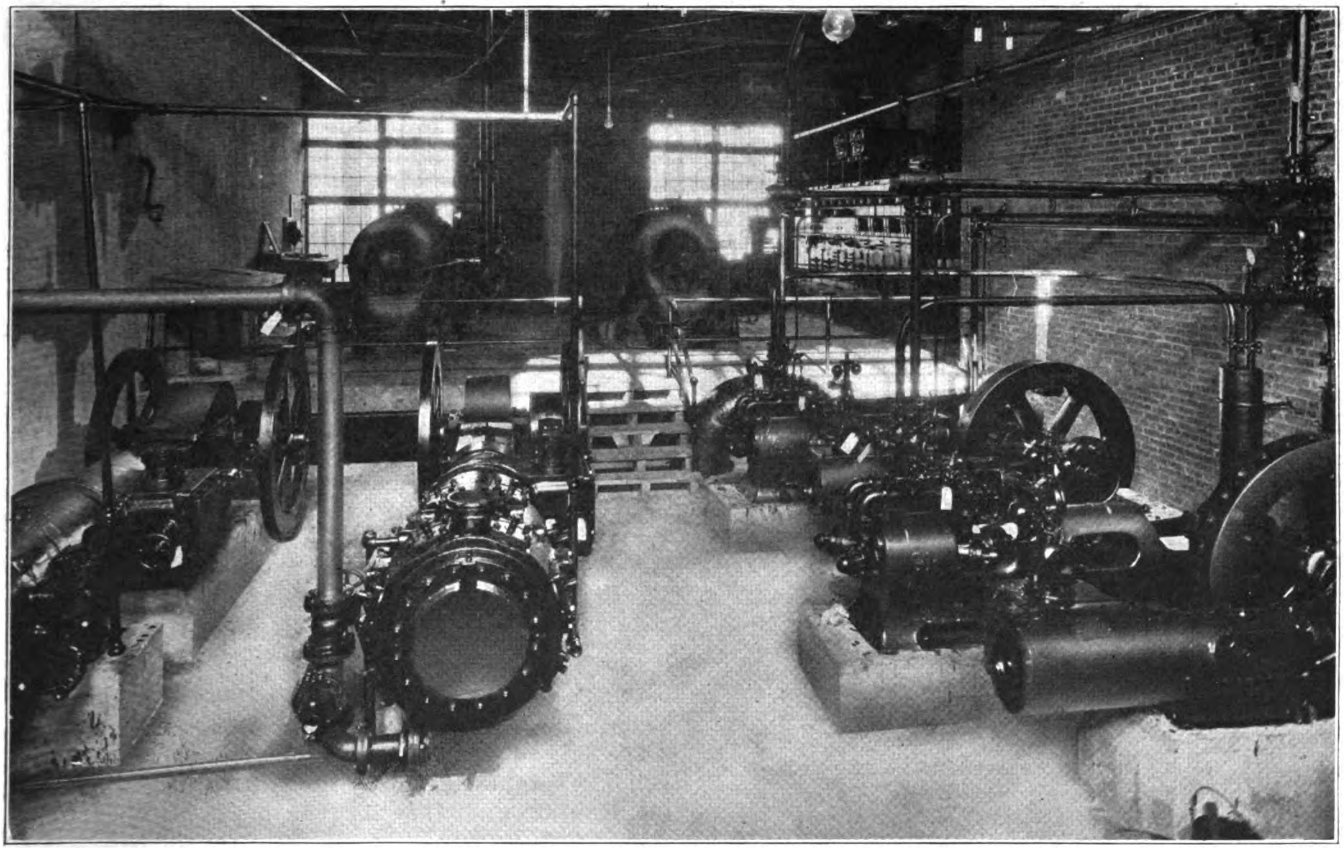


FIG. 8. PUMP HOUSE, AIR COMPRESSORS AND TURBINES

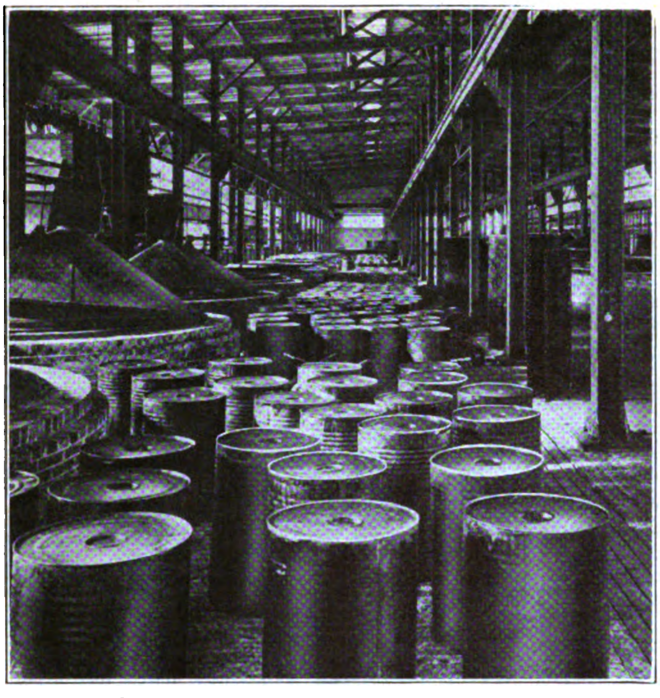


FIG. 9. CAUSTIC FUSION AND DRUM CHARGING BUILDING

LIQUID CHLORINE PLANT

It was decided that it would be best to build a plant for the liquefaction of chlorine gas to insure a pure supply of chlorine for manufacture of phosgene gas and to supply liquid chlorine for certain types of gas shell.

Owing to the fact that the Nelson cell produced such a very high quality of gas, it was found that it was not necessary to liquefy the chlorine for use in manufacture of phosgene. The liquefying plant was constructed from details furnished the Government by the Mathieson Alkali Co. of Niagara Falls, and the plant was erected under the direct supervision of Lieut. Col. Charles F. Vaughn, who came from the Mathieson Alkali Co. and was placed in charge of the chlorine gas plant. This plant was placed in operation just before the signing of the armistice.

The contract for the design of the chlorine plant was awarded on March 3, 1918. Definite location of the plant was decided March 27. The railroad track for serving the plant was completed May 8. Ground was broken for the shop building May 10. The first circuit of cells was ready to operate Aug. 1.

The first section of No. 1 cell building, having a capacity of 12.5 tons of chlorine gas per 24 hours, was started in operation Sept. 1, the circuits in this section being put in operation as rapidly as the chemical plant could absorb the gas. There were no difficulties encountered in starting, and operation was continued until the signing of the armistice. The plans furnished by the engineers were carried out without any changes during or after construction, and their estimates of cost would not have been exceeded had it not been for the extraordinary cost of labor due to high wages, much overtime and inefficiency.

The success of the entire work at Edgewood Arsenal was largely due to the great executive ability and personal force of Col. William H. Walker, upon whose shoulders rested the entire responsibility. All of his associates will remember him with admiration and respect.

Samuel M. Green Co.
Springfield, Mass.

American Institute of Mining and Metallurgical Engineers, Chicago Meeting

PLANS for the meeting of the American Institute of Mining and Metallurgical Engineers at Chicago next September are assuming definite form, and the committee in charge announces the following schedule of events:

On Monday, Sept. 22, the opening day, the morning will be devoted to registration of members and guests at the convention headquarters, the Congress Hotel. Monday afternoon the first session for presentation and discussion of technical papers will be held, and in the evening a smoker, at which the committee guarantees all traces of glaciation will be dissipated.

It is planned to make an excursion on Tuesday in a body, by a boat chartered for the occasion, across the south end of the lake to Gary, for a trip through the famous steel mills. Wednesday will be devoted to technical sessions, morning and afternoon, and in the evening the banquet will be held at the Congress Hotel, at which all members of the Institute and their wives will be the guests of Chicago.

On Thursday, a special train will convey the members and guests to La Salle and Depue, Ill., where the zinc smelters, coal mines and cement works will be visited. For those to whom these industrial operations are not of particular interest—this may include many of the ladies—there will be a trip by automobile to Starved Rock and other points of historical interest in the vicinity of La Salle.

For Friday, several optional excursions have been planned to local industrial plants. One trip will take in the lead refineries at East Chicago and the Standard Oil Refinery at Whiting. Another excursion will be to Milwaukee, to the plants of the Allis-Chalmers Co. and the Power Mining Machinery Co.; this trip will also include the metallurgical works at North Chicago of the Fansteel Products Co., where novel electrothermal processes in the production of metallic tungsten, molybdenum, cerium, and tantalum will be demonstrated.

For those interested in coal mining it is planned to have an excursion to the fields in Franklin and McCoupin Counties, leaving Chicago late Friday evening and spending Saturday at the mines.

Importation of German Scientific Books

In order to obtain a license for the importation of scientific books or journals which were printed in Germany, it will be necessary to deposit the purchase price with the American Relief Administration, so that the money may be available for the purchase of foodstuffs for Germany. The duplicate receipt issued by the American Relief Administration must be submitted to the Bureau of Imports of the War Trade Board when the application for the license is filed.

Removal of Tin Import Restrictions—Correction

The dates for shipment from point of origin and for entry have been changed by a recent War Trade Board ruling from those given in CHEMICAL AND METALLURGICAL ENGINEERING, June 15, 1919, p. 638, to June 30 and Aug. 1, 1919, respectively. Licenses for the purchase of tin are no longer required.

New and Rapid Apparatus for Electrochemical Analyses

By J. T. King*

IT HAS long been recognized in electrochemical analysis that agitation of the electrolyte hastens deposition of the metals. In an effort to keep apace with the modern demand of more speed in analysis, many mechanical devices and artifices have been introduced, employing the agitation principle. The best known types of these employ rotating anode, rotating cathode, rotating paddle, solenoid, and air streams. Analyses which formerly required many hours can now be satisfactorily performed in a few minutes. This saving in time has so revolutionized the usefulness of many electrolytic methods that the old objection of the time required can no longer in fairness be held against them.

While observing some of the apparatus employing moving electrolytes in operation, it occurred to the writer that stirring an electrolyte by rotating its containing beaker would be a more suitable and efficient method of agitation than others then in use. A careful search of the literature showed that no apparatus employing this principle had been described. The only reference to it having been tried was found in Smith's "Electro-Analysis." In mentioning the work performed by Klobukow (1886), one of the earliest investigators in rapid electro analysis, Smith states: "In his efforts to contrive mechanical devices, he rotated the cathode, and then the anode; indeed, he even held the electrodes stationary while moving the electrolyte." Before experiments were begun to ascertain the suitability of the new method of securing agitation, it was felt that, provided it was efficient, little would be gained unless simple and convenient apparatus could be designed to apply it in everyday use.

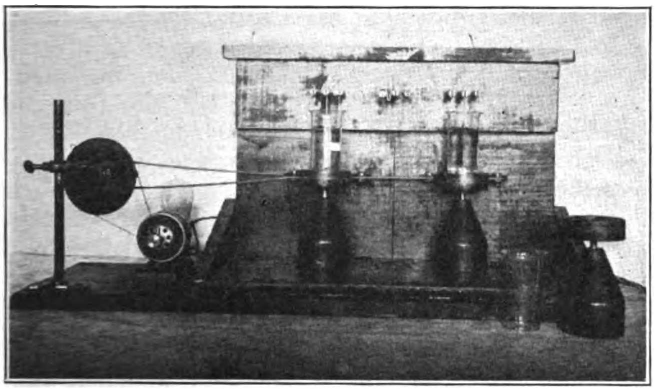


FIG. 1. THE EXPERIMENTAL DESIGN

In the assaying laboratories of the Departmen of Mining Engineering at the University of Toronto, the "Guess Haultain electrolytic outfit" (*Trans.*, A. I. M. E. Vol. 36) is used. It seemed that the rotating beaker idea could be successfully applied to this design, thereby retaining its best features, with the added advantage of speed.

Experimental Design

The apparatus was modified as in Fig. 1. Here three electrodes per cell were used, the cells being in series. A belt moving over the idlers provided means of revolving the upper parts of the stands, on which the beakers stood in a cup ¼ in. in depth. The lower part of the stands was weighted with lead, to impart stability when the upper part was in contact with the belt. Not over 60 r.p.m. could be used, as the beakers wabbled badly because of the small lateral support given by the cups. To overcome this the cups were increased in depth, when it was found that interference with the electrodes rendered difficult the operation of placing the beakers in position, also their removal. The cells were short circuited by inserting a metal plug between the electrode holders. Considerable speed and dexterity were essential in removing a cell with its stand, and introducing the plug, so that the current would not be broken while any of the cathodes with their plating were in contact with the acid solutions. Without rotation it required 10 hours to plate 1 g. of copper using N.D.$_{100}$ 3 amperes. The modified form reduced this time to two and a half hours.

An Improved Design

Profiting by the defects and limitations of this apparatus, another was made, shown in Fig. 2. The beakers were supported in cups, but these were fixed centrally under the electrodes above, and rotated by a belt from beneath. The cups were drilled a little large and in an annular recess inside, rubber tubing was placed to grip the beakers and take care of variations in their diameters. The electrode holders were movable vertically, electric contact being made in the upper compartment. These were of clamp form, and were a marked improvement over the rigid split holders, as they accommodated themselves to the variations in the thickness of the electrodes. Besides the three electrodes formerly used, a fourth or auxiliary one was introduced, placed behind the cathode and in parallel with it. At the end of an electrolysis, before the cathode was raised from its electrolyte, the auxiliary electrode was lowered into the solution. In this way none of the cells in the series were short circuited by the removal of the cathode, and current passed to it as long as it was in the electrolyte.

Good deposits of copper were obtained with as high as N.D.$_{100}$ 8 amperes, and 1 g. plated in 1½ hours. Rotating speeds up to about 200 per min. were practical; above this the flat cathode acted too much as a baffle, and splattered the solution out of the beaker. With

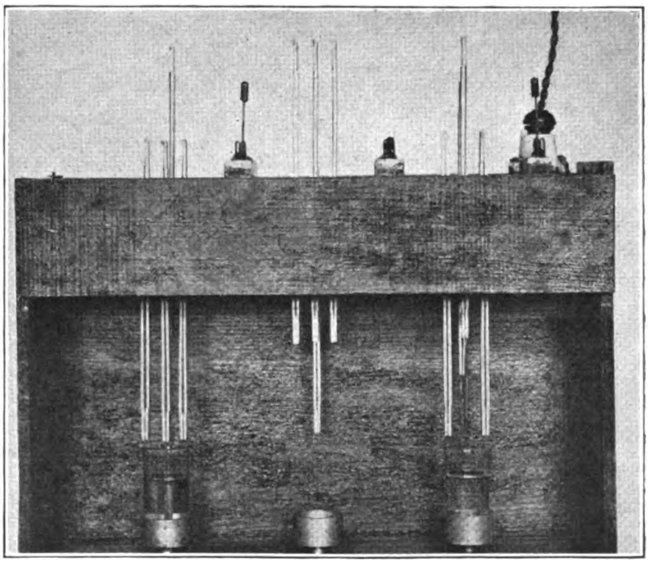


FIG. 2. THE APPARATUS IMPROVED

---

*Lecturer in mining engineering, University of Toronto.

the higher current density and higher rotating speed used here, it was expected that plating would be more rapid. It was noted that the plating was much heavier at the sides of the cathode than at the center; its whole area was not efficiently used. This was probably because the agitation in the beaker was more complete away from the central zone of the solution. The experiments showed that the flat form of electrode was not adapted to the method of agitation used. Cylindrical gauze cathodes were tried and found to be particularly adapted to the rotating beaker idea. Their use eliminated the necessity of a third electrode, as one anode placed in the center was sufficient. High rotating speeds could be used without the ill effects previously mentioned and uniform plating over the whole surface obtained. The apparatus would do excellent work in the hands of a sympathetic operator, but was not sufficiently practical for general use.

DESCRIPTION OF FINAL DESIGN

The final form of apparatus developed is shown in Fig. 3. Here many features have been incorporated to simplify the operation of rapid plating devices. The chief features which distinguish this from others, besides the novel method of stirring the electrolyte, are the system of wiring and the form of electrode holders. Fig. 3 shows four cell units marked *A*, *B*, *C* and *D*. *A* and *B* are in operation, *C* is being lowered from its electrodes, *D* is at rest. In the left hand compartment are housed a motor, its rheostat, a pilot lamp, ammeter, switch and two loose pulleys. A belt from the motor passes over the pulleys to the open or cell compartment, along the front and rear of four idler pulleys 1, Fig. 6, and around an end pulley. These are of aluminium with steel shafts running on a ball in the bronze bearings, supported on a cross frame. The five pulleys are spaced equidistant from the units in front. Four perpendicular wooden guide posts 2, see Fig. 6, attached to the base of the cabinet, are bored longitudinally and open to the front in a narrow slot 3. On each side of this slot are fastened upper and lower aluminium face plates 4 and 5. In the hole of the guide posts are long hollow cylindrical bearing tubes 6, of aluminium. From the lower part of these a threaded rod 7 extends forward through slot 3. On each rod in order from the face plate are an aluminium washer 8, known as the sliding contact, a rubber washer 9, and a nut 10. The bearing tubes are movable up and down the guide posts, and are held in any desired position by the tension of the rubber as adjusted by the nut. Steel spindles turning on a ball in the lower of two bearings of the tubes support the beaker cups 11, above. The cups have two rows of inwardly projecting rubber plugs, arranged to frictionally engage the beakers, thus centering them and accommodating any variations in their diameters that may occur. Above the cups are the electrode holders, one, 12, over the spindle axis or center of the beaker and one, 13, offset to the left. These are of broad clamp form, the outside jaw of each being stationary, the other movable. After passing up into the hollow top of the cabinet, these turn at right angles in wooden guides. A coil spring holds the jaws together. Push buttons 14 and 15 operate the movable jaws when desired. The electrical wiring is enclosed in hollow compartments with removable lids at the base top and back of the cabinet. Fig. 4 shows the electrolysis circuit diagrammatically, beakers being shown to correspond to the beaker positions in Fig. 3. The connection to the 110-volt. d.-c. lighting circuit used, and the lamp rheostat to control the cell current, are shown in Fig. 5, a rear view of the apparatus.

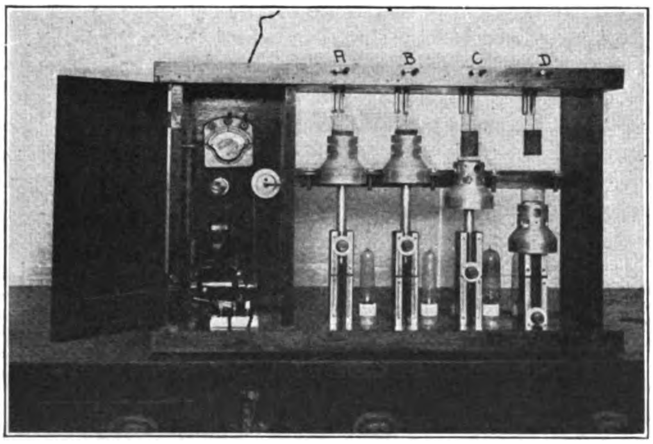


FIG. 3. FINAL FORM OF APPARATUS

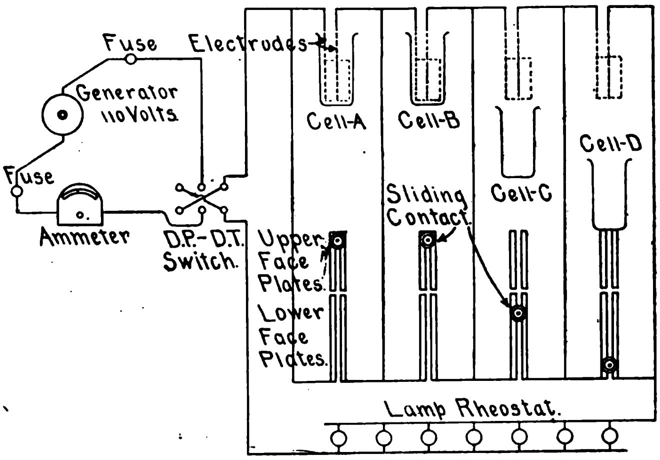


FIG. 4. DIAGRAM OF ELECTROLYSIS CIRCUIT

OPERATION

To follow the operation of the apparatus assume that the cups are in the lower position, as is cup *D* of Fig. 3. Beakers ready for electrolysis are in the cups, electrodes are in position, the belt is in motion at the desired speed as controlled by the motor rheostat. The current adjusted by the lamp rheostat will pass across the lower face plates through the sliding contacts. To operate any cell, it is raised by lifting the sliding contact nut until the electrodes are immersed in the electrolyte. On the way up, the cone face of the cup engages the belt and rotation begins. At the moment the sliding contact passes from the lower to the upper face plates, which are insulated, the electrodes will have met the electrolyte, current then passes through the cell. Any other cell may be put in operation similarly.

To terminate electrolysis on any cell, it is lowered to the starting position. The operator, with a beaker of wash water in one hand, lowers the sliding contact with the other hand, as shown in Fig. 6, transferring the water to the plated electrode quickly. The electrode is disengaged by pressing its button. While the cell is being lowered the current continues to pass through the electrolyte until the moment the solution leaves the elec-

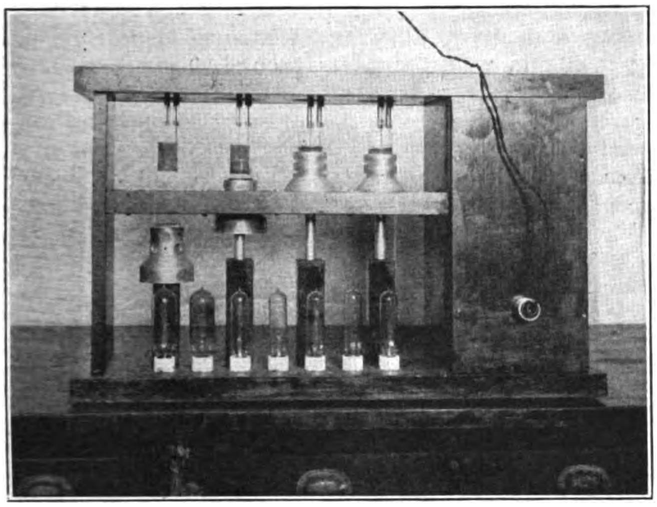


FIG. 5. CONNECTION TO LIGHTING CIRCUIT, AND LAMP RHEOSTAT

trodes, when the sliding contact has engaged the lower face plates. Then the current passes through the lower circuit of the cell. Thus the current is not broken in other cells that may be in operation, they are protected from resolution, and current is on the electrode being removed as long as it is in contact with its electrolyte. The procedure is extremely simple, convenient, speedy and positive.

The usual manner of fastening electrodes to their holders is by screws, chucks, slots and similar devices. Some of these are ruinous to the platinum ware that is used, and are difficult to clean when attacked by vapors from the electrolyte. They often do not give sufficient area of contact, causing burning of the electrode and consequent loss in weight. The contact area of the holders here is broad and smooth. The tension on the springs is adjusted so that while firm hold is exerted on the electrodes, it is not sufficient to injure them in any way. The faces are easily accessible for any cleaning that may be necessary, so that a perfect contact is assured. The push buttons provide an easy and quick way of inserting the electrodes and removing them. The set of four cathodes may be easily removed, rinsed in two changes of water, then two of alcohol, and set to dry, hanging over the lamps of the rheostat, in eighty seconds.

The apparatus runs very smoothly, requiring a minimum of attention from the operator. The ammeter and motor, being housed in a separate compartment, are amply protected from fumes and dust, and aluminium has been utilized wherever practicable in the exposed metal parts. The $\frac{1}{32}$-hp. motor used would operate many more units, so little power is required for rotation. It is balanced on a hinge underneath, thus accommodating itself to any changes occurring in the belt position when units are started or stopped.

TESTS FOR SPEED AND ACCURACY

In order to ascertain the speed of plating and the accuracy of the work, a number of analyses were made on copper solutions of known strength, and on unknown brasses. In order to determine the copper content of the copper wire used to make up the known solutions, duplicate analyses by electrolysis were made with gauze electrodes and still electrolyte. The method followed was that given by Heath in his "Copper Analyses," for "The Standard Five-Gram Electrolytic Assay." These gave 4.9906 and 4.9903 g., or 99.81 per cent copper.

The known solutions were made as follows: About 20 g. of the wire were carefully weighed, heated on a water bath with 40 cc. nitric acid, 40 cc. sulphuric acid and 100 cc. of water, until all the wire was in solution and nitrous fumes were driven off. When cool, the cover glasses and sides were washed down and the solution diluted to one liter at 15 deg. C. For the tests aliquot parts of 50 cc. were pipetted at once, using a pipette agreeing with the flask and transferred to the electrolysis beakers. Fifteen cc. of a saturated solution of potassium nitrate and 25 cc. of water were added, making 90 cc. of solution. This volume filled the beakers (new form, tall Fry) over half full, leaving over 1 in. clear at the top.

On several occasions while working with other apparatus it was observed that when higher current densities and an electrolyte containing nitric acid were used, the copper deposit actually dissolved off the cathode, while current was flowing, faster than the current flowing could plate it. In order to overcome this and retain the same character of deposit obtained at lower current densities, an equivalent amount of potassium nitrate was substituted for most of the nitric acid. When this was done the deposits were satiny, pink and adherent.

Cylindrical cathodes, 2 in. high and 1⅜ in. diameter, of 28-mesh, 28-gage copper gauze, were used. The stems were No. 16 copper wire, pushed through the top and bottom of the narrow lap of the gauze, the bottom end was turned back over the gauze and pressed to it. The upper ends of the stems were formed into an open loop, about ½ in. in diameter. These afforded large

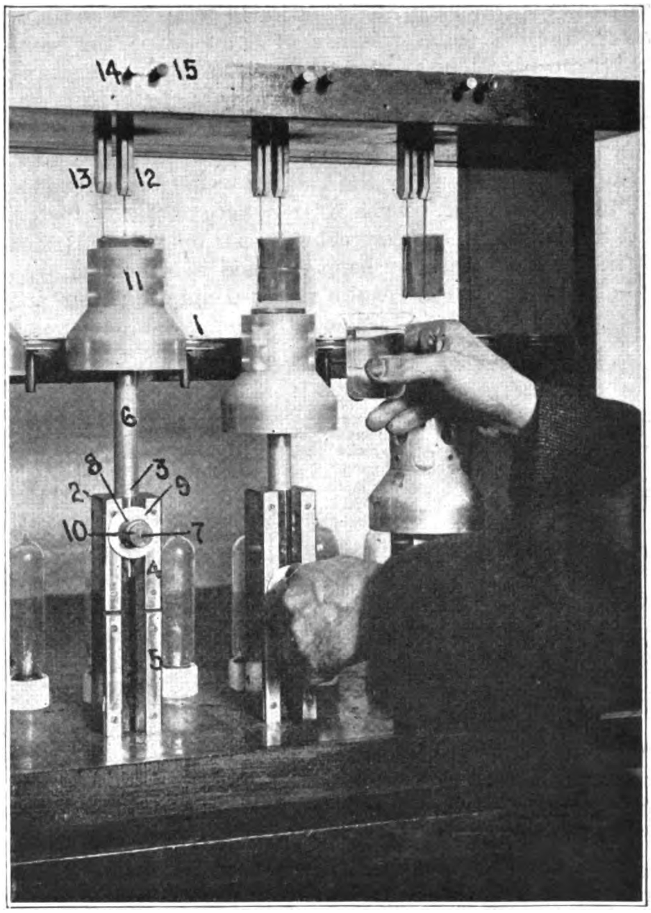


FIG. 6. OPERATOR TERMINATING ELECTROLYSIS

area of contact with the holders, and were easily hung over the lamps for drying after being washed. These cathodes are cheap, simply and quickly made, and with the exception of requiring cleaning in bright dip at least every second plating, are very satisfactory.

The immersion area was calculated to be about 100 sq.cm. This particular gauze was adopted after a series of experiments with various sizes and mesh had shown that this was the best, having sufficient rigidity, convenient weight (about 12 g.), and withstood the cleaning operations better than the others. For anodes strips of platinum foil 0.2 in. wide and 0.001 in. thick were used.

Speeds of rotation of about 500 per min. were used. As the tops of the gauze electrodes are set at the level of the electrolyte, any tendency to mount up the sides is counteracted and no splattering or throwing of the solution occurs. Table I gives the results of tests using 3 amp. current and a voltage drop of 3.7 per cell.

TABLE I

Time, Min.	Copper Deposited, Grams	Copper in Solution, Grams	Temperature of Electrolyte, Deg. C.
0	0.0000	0.9981	19
5	0.3231	0.6750	23
10	0.6252	0.3729	
15	0.8952	0.1029	
20	0.9904	0.0077	
25	0.9971	0.0010	
30	0.9979	0.0002	
34	0.9982	0.0001	
35	0.9980	0.0001	40
36	0.9981	0.0000	
40	0.9980	0.0001	
50	0.9981	0.0000	
60	0.9981	0.0000	

To confirm the completeness of deposition as indicated by weighing, the depleted electrolytes were tested colormetrically with a saturated solution of hydrogen sulphide water, against equal volumes of solution of the same acid concentration as the electrolyte, and containing 0.002 per cent copper. The usual spot plate test was found to be not sufficiently delicate. Tests after 34 min. plating time showed complete deposition of copper, though not indicated by the balance sensitive to 0.00005 milligram. The first wash waters were similarly tested, and in no case where complete deposition was indicated by the balance was any copper found in them.

Table II gives the results using 6 amp. current and voltage per cell of 4.1, also at 9 amp. and 4.9 volts.

TABLE II

Amperes	Time Min.	Copper Deposited, Grams	Copper in Solution Grams	Temperature of Electrolyte, Deg. C.
6	0	0.0000	0.9984	19
	5	0.6235	0.3759	
	10	0.9372	0.0612	
	15	0.9960	0.0024	51
	21	0.9977	0.0007	57
	25	0.9982	0.0002	
	26	0.9984	0.0000	
	30	0.9984	0.0000	63
	35	0.9983	0.0001	67
9	0	0.0000	0.9984	19
	15	0.9983	0.0001	
	16	0.9985	—0.0001	
	17	0.9984	0.0000	71

The deposits of copper without exception were a beautiful pink, satiny, adherent, and firm. These tests show the capability of the apparatus in rapidly plating these large amounts of copper quantitatively, showing that with 3, 6 and 9 amperes the amounts taken are plated in approximately 35, 26 and 16 min., respectively, within very close limits of experimental error. The curves in Fig. 7 show the results plotted from Tables I and II.

This apparatus is ideal for plating the copper of brasses and alloys, allowing of assured deposition on 1 g. in 40 min. with 4 amperes, though 30 min. is usually sufficient. Unknown brasses *A*, *B*, and *C* were analyzed for copper. To overcome the difficulty of selecting representative 1-g. samples, 10 g. were taken, treated with 25 cc. nitric acid and water 75 cc. to end of brown fumes, 35 cc. sulphuric acid was added and heated until all the copper was in solution, diluted, filtered and filter washed. The filtrate and washings were brought up to 500 cc. with water; 50 cc. aliquots pipetted, 15 cc. potassium nitrate and 25 cc. water were added in beaker. Electrolysis was continued 40 min. with 4 amp. current. Table III gives the results of the work on brasses, also the results on the same brasses by other operators on this and other stirred electrolyte apparatus.

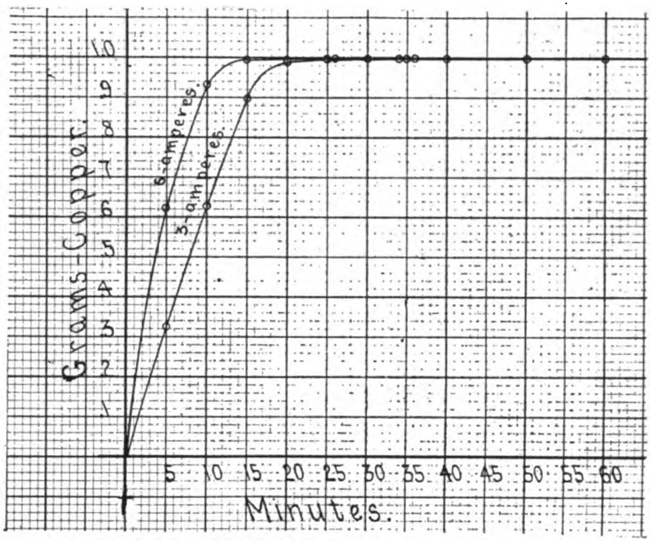


FIG. 7. CURVES SHOWING RESULTS AT DIFFERENT CURRENTS

TABLE III

Brass	Operator	Apparatus	Copper, Per Cent
Drillings A.................	W	Magnetic stirring	61.31
	B	" "	61.36
	G	" "	61.20
	G	" "	61.20
	Mc	Rotating cathode	61.30
	H	Air stirred	61.12
	K	King	61.33
	K	"	61.36
	K	"	61.35
Drillings B..................	D	Rotating cathode	62.82
	R	Dish cathode	60.68
	K	King	62.90
	K	"	62.83
	K	"	62.85
Cuttings C.................	F	King	67.64
	F	"	67.65
	K	"	67.59
	K	"	67.60
	K	"	67.56

The apparatus has been thoroughly tested in two laboratories of this university, and has been subjected to the rigors of constant use in a commercial laboratory for over a year, working on the determination of copper and lead in alloys and ores, where it has given excellent satisfaction in every respect.

SUMMARY

Electro-analytical methods using still and stirred electrolytes are discussed.

Results of experimental work with apparatus employing both principles are given and explained.

An apparatus of new design, exhibiting a new method of agitating the electrolyte (stirring by rotating the containing beaker) is described, together with preliminary apparatus leading to the adaption of the apparatus in its final form.

The operation of the apparatus and the method of carrying out an analysis are given in detail.

Tests carried out with the view of determining the accuracy and speed of the new apparatus are described and results tabulated.

A table showing results of experiments on three different brasses, obtained by this and other methods of stirring and carried out by different operators, is included.

In conclusion the writer wishes to express acknowledgment of his appreciation for many helpful suggestions from the staff of the Department of Mining Engineering and to Mr. J. T. Burt-Gerrans of the Electrochemical Department for data furnished, and tests made.

American Zinc Institute Meeting

DURING the war, zinc production was stimulated to such an extent that, at the present time, the producing capacity is much in excess of the normal demand. In view of this condition, it is not surprising to find the attention of the members of the American Zinc Institute centered upon the development of new uses for zinc.

At the annual convention of the Institute held at St. Louis on June 9 and 10, George C. Stone, of the New Jersey Zinc Co., presented a summary of the advantages offered by sheet zinc for building work, roofing, gutters, leaders, flashing, cornices and other architectural materials. This field appears to be the most promising outlet for large tonnage surplus. The Institute was urged to start an educational campaign similar to that carried out by the Vieille Montagne Co., which resulted in the recognition of the value of sheet zinc in Europe. In endeavoring to find new uses for zinc, it must be remembered that this metal possesses certain limiting qualities, such as: its low strength, high thermal expansion (about double that of iron), the tendency of wrought zinc to recrystallize and become brittle at relatively low temperatures, also that it is attacked by both acids and alkalis and it can be ignited at a much lower temperature than any of the other common metals.

OTHER SPEAKERS

The subject was discussed further by E. H. Wolff, of the Illinois Zinc Co., and George S. Harney, of the American Zinc Products Co. Mr. Wolff emphasized the fact that the durability of zinc roofs is not generally appreciated by architects. Mr. Harney urged the elimination of such misnomers as spelter, jack, galvanizing and sheradizing and the substitution of terms containing the word zinc. As a result, a recommendation that "zinc" be substituted for "spelter" in all quotations, specifications and contracts and also "zinc plate" for "galvanized iron," was passed unanimously. Provision was also made for the appointment of a publicity committee to request the Government statisticians, trade journals, the Associated Press and newspapers to make these substitutions in their reports.

The presentation of these papers was followed by a lively discussion on the part of the other members of the Institute, and resulted in the board of directors setting aside a considerable amount of money to advance this work. In this connection the plans of Dr. John Johnston, who during the war was an active member of the National Research Council, were referred to the proper committee for a prompt report to the board of directors.

ANNUAL DINNER

The annual dinner at the Hotel Statler was largely attended. Dr. W. F. Gephart, dean of finance and economics at Washington University, St. Louis, acted as toastmaster, and Edward Gengenbach, industrial commissioner of the St. Louis Chamber of Commerce, spoke on "Confidence and Progress." Pope Yeatman, at whose suggestion the Institute was formed, journeyed from New York to St. Louis to meet his old friends in the zinc world, and to talk to them on the "Influences of the War on the Zinc Industry." The speeches of the evening dealt with present and future conditions in the business world, the dominant note being "Forward, March!" The members voted to ask George C. Stone to make, in person, in the interests of the Institute, a survey of zinc conditions in Europe. Mr. Stone expects to sail early in July.

INTERESTING PAPERS READ

Among the other interesting papers read at the meetings were the following: "Some Causes of the Unsound Economic Position of the Zinc Industry in the United States," by William A. Ogg, president American Zinc, Lead & Smelting Co.; "Tri-State Mining and Production," by Otto Ruhl, C.E., Joplin, Mo.; "Mining and Production in Wisconsin," by A. M. Plumb, Wisconsin Zinc Co.; "Production of Zinc in the Southeastern States," by J. N. Houser, vice-president American Zinc, Lead & Smelting Co.; "Early Days of the Industry," by C. E. Siebenthal, of the U. S. Geological Survey; "Mines Taxation," by R. C. Allen, director, Geological and Biological Survey, Michigan. An interesting moving picture lecture on "Safety Lessons in Metal Mining" was given by B. F. Tillson at the close of the Monday meeting. The badges worn by members were made of zinc and a diversified exhibit of new uses for zinc was displayed at the unique registration booth of the Institute in the corridor of the Hotel Statler.

A budget of $20,000 to forward the aims of the Institute was approved by the members, which now number nearly 200, and the following officers and directors were elected:

OFFICERS

Term expiring 1920: President, Charles T. Orr; first vice president, Edgar Palmer; second vice president, James L. Bruce; third vice president, F. C. Wallower; treasurer, Howard I. Young; secretary, Stephen S. Tuthill.

BOARD OF DIRECTORS

Term expiring 1920: George O. Argall, Joseph Brennemann, Arthur Thacher, C. M. Loeb, Edward M. McIlvain, George E. Nicholson, F. C. Wallower; term expiring 1921: J. H. Billingsley, P. B. Butler, Julius W. Hegeler, Cornelius F. Kelley, William A. Ogg, Edgar Palmer, O. S. Picher; term expiring 1922: James L. Bruce, A. P. Cobb, A. S. McMillan, Charles T. Orr, Victor Rakowsky, Wm. F. Rossman, E. H. Wolff.

The next meeting of the Institute will be held in Chicago on the second Monday in May, 1920.

Treatment of Complex Speisses*

Description of Recent Research on the Treatment of Complex Speisses and the Application of the Results to Commercial Metallurgical Processes—Proposed Method of Treating With Pyrites in an Electric Furnace

BY PAUL PAPENCORDT
Translated by Oliver C. Ralston

AMONG the many intermediate products obtained in metallurgy which make it difficult to prepare pure metals direct from the ores, the speisses are perhaps the most troublesome because the recovery of the valuable metals from them is attended with unusual difficulty. It is not many years since speisses were discarded even by large smelters. In those smelters where speisses are treated the methods are tedious and often expensive. The purpose of this work was to devise a simpler process not subject to the excessive losses now suffered by smelters.

The speiss on which the tests were made came from the copper smelter at Oker-a-H. Its composition was as follows:

	Per Cent.		Per Cent.
Cu	23.50	Ni+Co	2.90
Pb	16.30	Zn	3.10
As	12.20	S	2.10
Sb	13.20	Au+Ag	0.12
Fe	26.20		

Just how far the constituents of such a complex are chemically united and how much they are in solution in each other is difficult to determine. Among the binary systems of various elements with arsenic or antimony which have been studied we find the following described by Friedrichs in the volumes of *Metallurgie* from 1905 to 1908:

In the system copper-arsenic there are two chemical compounds, Cu_3As and Cu_5As. However, the arsenic is only loosely bound in the copper-arsenic alloys. Alloys high in arsenic lose most of it by merely standing in powdered form in a space heated to 300 deg. C. or higher.

In the system iron-arsenic the following compounds are found: Fe_2As, Fe_3As_2 and apparently FeAs. The compound Fe_2As forms a eutectic with arsenic which freezes at about 830 deg. C., but it forms mixed crystals with Fe_3As_2 if cooled quickly. The compound Fe_3As_2 is the product of a reaction which takes place at about 800 deg.

In the system nickel-arsenic there are two compounds, NiAs and Ni_5As_2. The existence of NiAs is well proved, but that of Ni_5As_2 is doubtful. Nickel-arsenic alloys have not hitherto been roasted and refined with much success.

In the system iron-antimony are two compounds, Sb_2Fe_3 and Sb_2Fe. In the system cobalt-arsenic are Co_5As_2, Co_2As and Co_3As_2.

The main object to be obtained is to eliminate the arsenic and antimony from these speisses. In practice this is done by roasting either the molten or non-molten material, and a strong blast of air is passed either through or over it so that more or less of the arsenic and antimony are removed as volatile oxides. For instance, the process used at the copper smelter in Oker-am-Harz consisted in treating speiss in the so-called speiss-furnace by the "blast-process." This furnace had water-cooled top and bottom. The side walls, arch, fire-bridge and flue gas ports were of firebrick. The hearth was built in three layers. On the iron bottom was laid a layer of tamped marl covered with the layer of firebrick. This was made of a mixture of 20 parts of slate splinters with 80 parts of crushed marl. The furnace was fired by simple reverberatory firing with under-draft. The excess air for oxidation was led in through two nozzles. The refining or 'blowing' process took place in the following manner: After the charge had been placed in the furnace all openings were luted shut and the temperature was raised to a glowing red. Several hours were allowed at this temperature for the roasting. Then the temperature was raised suddenly, compressed air turned on and the charge allowed to melt and the dross to separate. First the iron oxides and slags with the hearth; then the antimony and lead oxidize and enter the iron silicate slag, making it very basic. The greater portion of the arsenic can be volatilized only after these elements have been slagged, and during this stage the temperature of the furnace can be so lowered that the contents of the furnace become quite pasty. The removal of the arsenic is indicated by the cessation of fumes, after which the firing is increased again and the concentration of the speiss has been accomplished.

ANOTHER PROCESS

Another interesting process for the working of speisses is given by Guillemain in *Metallurgie*, 1910, 598. Here the speiss-bath was blown with dry chlorine gas. The antimony and arsenic were removed very well, but the process proved too expensive. Guillemain later directed his attention to cheapening the ordinary dearsenification methods. He used blast-roasting methods similar to those used in the Savelsberg and the Huntington-Heberlein processes for lead ores. The groud speiss was mixed with difficultly-fusible material like limestone, or acid slag, and either preheated before placing in the blast pots or only partially heated before filling the pots in the regular manner. By blowing to a glowing red most of the arsenic and antimony volatilized as As_2O_3 and Sb_2O_3.

---

*Translated from *Metall und Erz*, 16: 6-13 (1919). This paper was given as a communication from the Institut für Metallhüttenwesen und Elektrometallurgie der Kgl. Techn. Hochschule Aachen, and gives the results of some tests on the treatment of complex speisses which could only be carried out on a small scale, due to war conditions. The suggestions embodied in the paper have great promise of solving more satisfactorily the treatment of such undesirable complexes as are met in the speisses of some copper smelters. Pure arsenic sulphide is sold as a rather expensive pigment which has mostly been produced in Germany until war conditions shut off the supply. If any German smelters start using this method of working up their complex speisses they will be able to undersell manufacturers of arsenic sulphide as it is made at present in the United States.—[TRANSLATOR.]

All of these processes give a mixture of metal oxides which are by no means free of sulphides of arsenic and antimony. A glance at the voluminous literature on beneficiation of such products is sufficient to show that the treatment of these mixtures is attended with great difficulties. No process has ever been in the least satisfactory. The process of Schilowski, developed at the Institut für Metallhüttenkunde und Elektrometallurgie der Königliche Technischen Hochschule zu Aachen, (see *Metallurgie*, 8, 617, 1911), for electric smelting of copper ores containing arsenic, seemed to offer the best chances of success. In this process the arsenic was completely volatilized as a sulphide and condensed in a small condenser. As to whether antimony could be similarly removed, only tests could tell.

These tests relied on electric melting with exclusion of all air combustion gases. The melting of the speiss was performed in a graphite crucible into which projected two carbon electrodes, forming an arc furnace (see Fig. 1). A hole was bored into the bottom of the crucible and a carbon electrode fitted in, while the others were introduced through corresponding holes in the cover. The bottom of the crucible was covered with tar and the side was fitted with a suitable delivery tube leading into an iron box condenser which was divided into a number of compartments. This box served to condense the sublimed products and the opposite end was connected to a ventilating chimney to dispose of any gases.

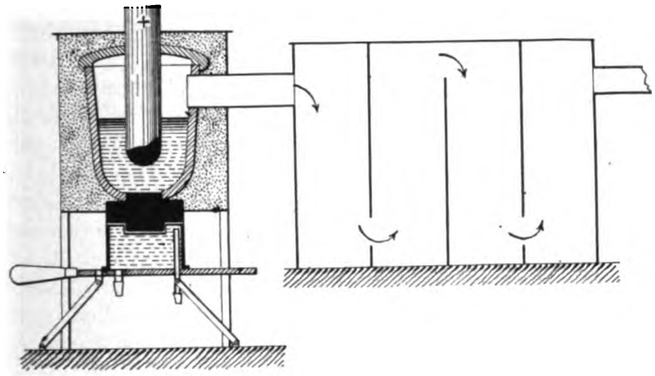


FIG. 1. FURNACE IN WHICH TESTS WERE MADE

The speiss contained only 2.1 per cent sulphur, and it was therefore necessary to add enough to form sulphides with the arsenic and antimony. Pyrite seemed to be the best addition agent. A sample of pyrite containing 35.1 per cent sulphide was used. In order to convert the other metals into sulphides it was necessary to add the following amounts:

		Per Cent.			Per Cent
Cu	into Cu_2S	6.0	Co-Ni	into $(CoNi_3)S_2$	1.5
Pb	into PbS	2.0	Zn	into ZnS	5.0
As	into As_2S_3	7.5			
Sb	into Sb_2S_3	5.0		Total	38.5
Fe	into FeS	15.0			

Since the speiss contained 2.1 per cent sulphur, 36.4 per cent sulphur had to be added. In these tests, therefore, the speiss and pyrite were both powdered and mixed and then melted together in the furnace, with exclusion of air. Each test took 20 minutes.

TEST 1

A charge of 1 kg. speiss with 0.5 kg. pyrite was melted. In a very few minutes after turning on the current brown fumes poured out of the outlet of the condenser. The color and smell indicated arsenic sulphide. The evolution of the arsenic sulphide was so fast that the condenser proved to be too small for complete condensation of the arsenic sulphide.

The results of this test were: a speiss which had settled to the bottom; copper matte, a glassy slag and a sublimate. Analysis gave:

Matte:	Per Cent	Antimonial Speiss:	Per Cent
As	0.11	As	0.27
Cu	25.8	Cu	7.96
Sb	0.15	Sb	17.94

Copper Balance

Charge contained: 1000 g. speiss with 23.5 Per Cent Cu = 235 g. Cu

Products contained:

685 g. matte with	25.8 Per Cent Cu =	176.0 g. =	74.89 Per Cent
725 g. speiss with	7.96 Per Cent Cu =	57.7 g. =	24.57 Per Cent
220 g. slag with	0.17 Per Cent Cu =	0.4 g. =	0.15 Per Cent
	Loss,	0.9 g. =	0.39 Per Cent
	Total,	335 g.	

TEST 2

In this case 1 kg. of speiss was melted with 1 kg. of pyrite in the same manner as in Test No. 1, and enough sulphur was present to convert all the metals into sulphides. It lasted 20 min. and the products again were matte, speiss, slag and sublimate.

Matte:	Per Cent	Speiss:	Per Cent
As	0.0	As	0.08
Cu	26.2	Cu	3.66
Sb	0.03	Sb	16.52

Copper Balance

Charge contained: 1000 g. speiss with 23.5 Per Cent Cu = 235 g. Cu

Products contained:

780 g. matte with	26.2 Per Cent Cu =	204.36 g. =	86.96 Per Cent
790 g. speiss with	3.66 Per Cent Cu =	28.82 g. =	12.22 Per Cent
250 g. slag with	0.21 Per Cent Cu =	0.52 g. =	0.27 Per Cent
	Loss	1.3 g. =	0.55 Per Cent
	Total	235 g.	

TEST 3

In this test 1 kg. of speiss was melted with 1.5 kg. of pyrite, meaning an excess of sulphur, but again there were matte, speiss, slag and sublimate.

Matte:	Per Cent	Speiss:	Per Cent
As	0.0	As	0.02
Cu	28.3	Cu	4.15
Sb	0.031	Sb	16.8

Copper Balance

Charge contained: 1000 g. speiss with 23.5 per cent Cu = 235 g. Cu

Products contained:

710 g. matte with	28.3 Per Cent Cu =	200.93 g. =	85.15 Per Cent
780 g. speiss with	4.15 Per Cent Cu =	32.37 g. =	13.70 Per Cent
280 g. slag with	0.23 Per Cent Cu =	0.60 g. =	0.20 Per Cent
	Loss	1.10 g. =	0.40 Per Cent
	Total	235 g.	

From these three tests it could be seen that in all three cases there was obtained a copper matte containing only traces of arsenic, a speiss free of arsenic but rich in antimony, a slag and a sublimate. Also most of the copper could be converted into a matte. A small amount of arsenic in the matte of Test 1 was due to deficiency of sulphur. Still the matte contained on an average 85 per cent of the copper and the remainder insisted on staying in the antimony speiss. In the speiss nearly all of the original antimony was present. This was confirmed by analysis of the sublimate.

Four more tests were made to see if a longer time in the furnace would cause the antimony to volatilize as Sb_2S_3. Test 4 lasted 25 min., Test 5 lasted 30 min., Test 6 lasted 40 min. and Test 7 lasted 50 min. The results scarcely varied from those already reported.

CONCLUSIONS

It therefore seemed safe to conclude that by melting a speiss in an electric furnace with pyrite and with exclusion of air there can be obtained:

(*a*) Copper matte, free from arsenic, containing most of the Cu.

(*b*) Antimony speiss, free from arsenic, containing the remaining Cu.
(*c*) Barren slag.
(*d*) Arsenic sulphide sublimate.

The arsenic of the original speiss was almost completely volatilized, while the antimony was almost completely recovered in the new speiss. That most of the arsenic was also in the sublimate was later confirmed by analysis, and it also contained very little antimony. Most of the original speiss had been converted into a leady copper matte, the subsequent treatment of which will be mentioned later.

TESTS ON THE NEW SPEISS

The new speiss still contained enough copper to make another operation for the recovery of this copper necessary. It is well known that antimony sulphide is soluble in water solutions of alkali sulphides forming sulphantimoniates. The new speiss was pulverized, mixed with coal and sodium sulphate and heated in a Helberger crucible furnace in order to convert the antimony of the speiss into sodium sulphantimoniate. The reaction is:

$$Sb_2S_3 + 3Na_2SO_4 + 6C = 2Na_3SbS_3 + 6CO_2$$

The fused mass was allowed to cool, pulverized and leached with hot water in a rotating glass barrel which was kept heated by bunsen burners. The results of the tests were as follows:

Test	Speiss Leached	Time, Hr	Water, cc.	Antimony Dissolved,	
				g.	Per Cent
1	100	1	1000	12.13	73.00
2	100	2	1000	14.78	89.00
3	100	3	1000	16.43	99.45
4	100	4	1000	16.45	99.58
5	100	5	1000	16.48	99.75

These tests showed that the leaching of practically all of the antimony took place in 3 hr. and that only traces were extracted by longer leaching. The residue contained the copper, lead and iron as sulphides, together with the precious metals, and could be combined with the copper matte to be treated by standard methods. The fact that the antimony in the speiss was soluble in water as Na_3SbS_3 makes it possible to isolate it as a by-product which can be converted either into antimony pigments or into metal. Some iron sulphide seems to dissolve, imparting a turbidity to the solution. Metallic antimony can easily be obtained by electrolysis of this solution.

To test this latter process an accumulator jar was used for electrolytic bath with lead sheet anodes and sheet iron cathodes. A tension of 2 v. was used, and in order to prevent precipitation of iron with the antimony some common salt was added to the electrolyte. At the end of the electrolysis the antimony was present on the cathodes as gleaming plates. The solution electrolized originally contained 8.21 g. of antimony and the weight of deposited metal was 8.21 g. Hence the loss of antimony is very small, and the earlier work of Borchers (Lehrbuch der Elektrometallurgie) has shown that the electrolysis is very simple.

TREATMENT OF THE SUBLIMATE

In these tests the sublimate from the original Test 2 was used. In this test 210 g. of sublimate with an arsenic content of 45.3 per cent had been obtained, and it was also found that it contained 0.47 per cent Cu. The original charge of 1 kg. speiss had contained 121 g. arsenic, and the 210 g. of sublimate contained only 95.13 g., showing that 25.87 g. had been lost. This corresponded to a recovery of 78 per cent. The arsenic was present as As_2S_3 and in order to be obtained pure from sulphides of copper, iron, lead and zinc it had to be resublimed at a temperature of 700 deg. C.

A lot of 50 g. was heated between 700 and 800 deg. with exclusion of air and a brown vapor passed over into a water-cooled condenser. The 50 g. of material tested contained 22.6 g. arsenic and the sublimate contained 35.2 g. with 59.8 per cent As, or 20.79 g. arsenic, meaning a recovery of 92 per cent of the arsenic. This was done in a carbon crucible and there remained a residue of copper, nickel, iron and arsenic. This residue could be treated with the original speiss in practice.

Analysis showed that the resublimed arsenic contained no impurities except some free sulphur: In practice such a pure product might be difficult to obtain with a single resublimation, but it could be resublimed.

TREATMENT OF THE COPPER MATTE

The arsenic-free copper matte contained a great deal of lead as well as some nickel and cobalt, and the same was true of the residue from the antimony leaching. Rauschenplat has shown (*Metallurgie* 7:154, 1910) that the lead can be slagged away from the copper very easily by forming a siliceous slag. Therefore part of the matte was pulverized, mixed with silica and dead-roasted in a muffle until sintering commenced. This was then mixed with some unroasted matte and more silica and melted in an electric furnace, sketched in Fig. 2, to allow the reaction process to take place.

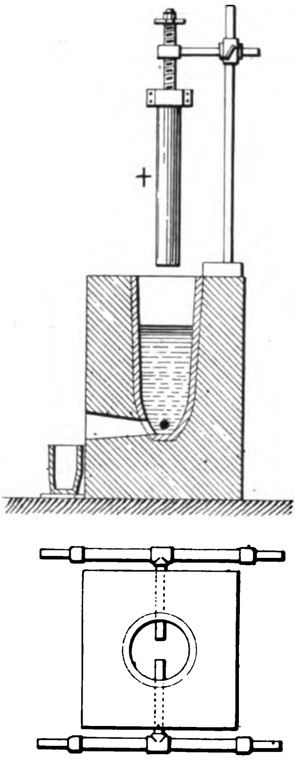


FIG. 2. ELECTRIC FURNACE IN WHICH THE COPPER MATTE IS TREATED

The result was a black copper metal containing the precious metals and nearly all of the nickel and cobalt, while the slag contained the iron and practically all of the lead in the form of silicates. The copper contained 92.4 per cent Cu, 6.7 per cent Ni and Co, and 0.25 per cent Fe. This product can enter the commercial copper-refining processes, especially the electrolytic refining process, which recovers all the metals mentioned. No tests were made, since it is known that it is possible to make cathode copper, anode slime containing the precious metals, and the nickel and cobalt enter the electrolyte. The lead silicate slag can also be treated by the roast-reduction process to form work-lead, a process which is standardized.

SUMMARY

The method of treatment of the speiss will therefore be: Melting in the absence of air and with the addition of pyrite in an electric furnace, whereby the volatile products can be conducted away and condensed. The products obtained are:

1. Arsenic-free copper matte with traces of antimony, but containing at least 80 per cent of the copper con-

tent of the speiss. The copper content of the matte amounts to 25 per cent.

2. Antimonial speiss with traces of arsenic and up to 4 per cent Cu, which amounts to about 20 per cent of the total copper content of the original speiss.

3. Sublimate, consisting essentially of arsenic sulphide but contaminated with small amounts of sulphides of copper, iron, lead and zinc.

The copper matte is mixed with silica and dead-roasted, followed by smelting with unroasted matte, giving copper metal which contains the precious metals and the nickel and cobalt.

The antimonial spiess is powdered, mixed with sodium sulphate and coal and melted. The melt is leached with hot water to form a solution of Na$_3$SbS$_4$ and the residue, containing copper, lead, nickel and cobalt sulphides with traces of precious metals, is worked up with the copper matte. Metallic antimony is thrown out of the solution by electrolysis.

The sublimate is resublimed at about 700 deg. C. forming arsenic sulphide, which finds direct commercial application. Nearly all other processes of treating speisses do not recover the arsenic and antimony in the form of easily marketed by-products.

COMMERCIAL APPLICATION OF THE NEW PROCESS

It is now possible to outline the fundamentals of a new metallurgical treatment of speisses. The proposal was to melt speisses with pyrite in an electric furnace, but in practice it would be more profitable to use cupriferous pyrite or pyrite containing precious metals. Only a carbon-lined electric furnace seems proper for the melting and in order to prevent the corrosive action of the molten speiss it would be best to water-cool the bottom and the bottom third of the side walls. Since metallurgical speisses are ordinarily formed in a molten state, they should be collected in a fore-hearth in the copper smelter and then fed into the electric furnace in the molten state. Here the pyrite is added in the calculated proportion, the furnace closed air tight and the current of electricity passed for a time. Only a small energy consumption need be met in the furnace and the only doubtful point is whether the pyrite and speiss get thoroughly mixed. The liquid contents of the electric furnace are then tapped out.

The new antimonial speiss, by virtue of its high specific gravity, is found on the bottom of the furnace and is tapped first. It is ground, mixed with sodium suphate and coke, and placed in a preheated smelting furnace, whereby the antimony is converted into sodium sulphantimoniate. The contents of the crucibles are poured out. Any floating matte is removed and worked up later. The melt is cooled and pulverized and leached with hot water.

Leaching apparatus should consist of iron vats with conical bottoms and steam inlets to warm and stir their contents. Other settling tanks are needed and slime-filters to separate the solution from the residue of copper, lead, iron, etc. The solution should be electrolyzed according to Borchers' process. (See Borchers' "Elektrometallurgie.")

The antimony electrolysis installation should consist of a series of vats in cascade. The baths will be rectangular iron vessels in which are hung alternately sheets of lead and of iron as anodes and cathodes. The vessel also forms a cathode. Since the solution becomes specifically lighter during electrolysis, the liquor must flow into the bottom of each cell and overflow from the top. The current density must fall with the antimony content of the solution. About 100-150 amp. per sq.m. is all right at the beginning, but toward the end only 40-50 amp. per sq.m. can be used. This can be done by building baths progressively longer. The antimony scales or powder stick in part to the iron cathodes and part falls to the bottom of the cells. Since the solution contains some iron, the deposited antimony contains some iron, and this must be removed during the melting of the antimony by adding antimony sulphides to the metal or by adding some common salt. The leach liquor is oxidized by air and concentrated until sodium hyposulphite crystallizes out. This is an article having a wide market.

Passing to the treatment of the crude sublimate, it was found that the red color was due to the presence of As$_2$S$_2$, and in separating from the other metal sulphides it is necessary to resublime it in a Freiberger subliming furnace. This consists of three tiers of 12 clay retorts, each of which are about 1.5 m. long and 12 cm. in diameter (4.5 ft. x 5 in.). The material is introduced into the back ends of the retorts, and these are heated to a dull red glow. After carrying out the sublimation the residue is taken out and added to the next charge of speiss that is melted in the electric furnace with pyrite. The sublimate which collects in the condenser is the arsenic sulphide of commerce.

The treatment of the copper matte should be as follows: The matte is pulverized, mixed with the cupriferous residue of the antimony leaching and with silica, and roasted either in a stationary furnace or a revolving roasting furnace. The temperature will be held at such a point that incipient sintering takes place. The roasted material is then mixed with unroasted matte in the proper proportion and treated in a shaft furnace, forming metallic copper containing cobalt, nickel and the precious metals. This is an article of commerce, or it can be electrolytically refined. The lead from the matte passes into a silicate slag from which it can be smelted by standard processes, forming work-lead.

Spelter Production in United States

The Department of the Interior, by the United States Geological Survey, reports as follows on spelter produced in the United States, during 1917-18.

	Short Tons	Average Price per Lb.	Short Tons	Average Price per Lb.
Illinois	172,489	......	141,844	....
Kansas	76,048	......	29,149	....
Oklahoma	204,394	......	139,066	....
Pennsylvania	86,995	......	77,342	....
Other States	104,438	......	91,610	....
Electrolytic	25.209	......	38,916	....
Total primary	669,573	......	517,927	....
From domestic ore	584,597	......	492,405	....
From foreign ore:				
Australia	26,140	......	1,780	....
Canada	6,787	......	8,700	....
Chile	......	......	886	....
Italy	2,951	......	113	....
Mexico	40,360	......	14,043	....
Spain	8,738	......	......	....
Total foreign	84,976	......	25,522	....
Total primary	669,573	......	517,927	....
Redistilled secondary	16,835	......	9,597	....
Total	686,408	......	527,524	....
Grade A	97,707	14.0c.	129,023	11.1c.
Grade B	69,189	12.7c.	68,987	10.7c.
Grade C	148,749	9.4c.	98,584	8.0c.
Grade D	370,763	9.0c.	230,930	7.9c.
Total	686,408	10.2c.	527,524	9.1c.
Total value	$140,027,000		$96,009,000	

Manufacturing Plant of the Providence Gas Co.—I

Review of the Development of the Gas Industry in Providence, R. I.—Description of the Plant as It Was Before the Installation of the Koppers Combination Gas Ovens

BY WALTER M. RUSSELL*

THE City of Providence, Rhode Island, U. S. A., is located at the head of Narragansett Bay, about thirty miles from the open ocean. The city proper has an area of something over 18 sq.m. and a population within this area of about 250,000. As a seaport, it ranks tenth in the United States in bulk of tonnage and value of cargoes, having direct connection by water with Philadelphia, Baltimore, Norfolk and Mediterranean ports. It is the leading oil port of New England and with the completion of a new 30-ft. channel will have one of the best harbors in the world.

Providence is a great manufacturing city, being first in the country in the manufacture of jewelry and silverware, also having the largest mechanical tool factory, file factory, engine factory, screw factory and silver factory in the world. It is surrounded by the greatest textile districts of the country.

Gas is supplied to the city proper, also to Olneyville, cities and towns of North Providence, East Providence, Cranston, Riverside, Barrington, Warren and Bristol, serving in all about 65,000 consumers, utilizing some 450 miles of mains.

Being the center of a great industrial section and known as the "southern gateway" of New England, it is the logical point for the distribution of gas and coke to industries requiring these commodities.

The Providence Gas Co. first commenced operations in the year 1848. A coal gas works was erected on the east side of the Narragansett Bay and became known as the East Station. This gas works continued in operation until the year 1870, at which time the output of gas was about 132,000,000 cu.ft. per year.

In 1870 a new gas works was built on the west side of the Bay, called the West Station. This plant was considered a model for its time and it was in this works that some of the first recuperative benches in the United States were successfully operated. Coal gas only was made in this plant until the year 1891, when water gas sets were installed.

In 1877 the Citizens Gas Co. began operations in opposition to the Providence Gas Co. During the '70s there was a great deal of activity in the United States on the part of opposition gas companies. These were usually organized by promoters for the purpose of putting up a plant which would later have to be bought out by the established company at a profit to the promoter. As a rule, these companies put up cheap water gas plants, but in this case there was an exception, as the Citizens Gas Co. built a coal gas plant which was purchased by the Providence Gas Co. in the year 1878 and became known as the South Station. In 1890 water gas sets were built in this works. The West Station then became known as the North Station, and these two works, the North Station and the South Station, continued in active operation, making coal and water gas, until 1911.

THE SASSAFRAS POINT STATION

Between 1900 and 1906, the output of gas increased 50 per cent and in 1905 it became evident that the capacity of these stations would soon be exceeded; also both the North and the South Station were situated where adjoining land was extremely expensive to purchase and the land already owned was so closely covered with buildings as to allow of no further expansion. It was, therefore, determined to plan for the future, and 40 acres of land were purchased situated about two miles southerly from the town, bordering on Narragansett Bay and having a railroad connection with the New York, New Haven & Hartford Railroad. During the next four years, many plans were carefully considered, which culminated in the construction of an entirely new coal gas plant at the new site, which became known as the Sassafras Point Station.

In 1910 the North Station was abandoned and the following year, with the starting of the new coal gas plant at the Sassafras Point Station, coal gas was discontinued at the South Station, it being continued only as a water gas plant. The output for the year 1910 was 1,386,819,000 cu.ft.

In January, 1909, a contract was let to the Didier-March Co. to build a retort house complete from the coal crusher to the coke storage bins; the retort house to be capable of housing four batteries of retorts, two only being built at first. These batteries each consisted of six benches, containing ten retorts, making 120 retorts in the first installation. This was followed by a third battery of 60 retorts in 1911, and in 1912 a fourth stack was built of six benches each, containing 15 retorts; so that the total capacity of the house was 270 retorts. The construction of the coal handling equipment, condensing and purifying buildings and equipment and the meter house and power house equipment was done by the Bartlett Hayward Co.

Ground was broken April 1, 1909, and the first gas was made in October, 1910. The system of coal carbonization adopted was the Dessau vertical retort slightly modified to meet American conditions. The plant as finally completed had a nominal daily capacity of 3,200,000 cu.ft., and was in operation until January, 1919, when the retorts were abandoned and a battery of 40 Koppers combination gas ovens were turned on.

ALL MANUFACTURING PLANTS COMBINED

In 1916 a new water gas plant was built at Sassafras Point and all manufacturing was abandoned at the South Station, thus bringing all the manufacturing plants together at one works. In 1905 a 4,000,000-cu.ft. holder was built near the South Station. In 1911 a 6,000,000-cu.ft. holder was built at Sassafras Point and in 1915 a 3,000,000-cu.ft. holder was built in a suburb of Providence for reinforcing the supply in that district. All holders were built by the Bartlett Hayward Co. and are telescopic holders contained in steel plate tanks on concrete foundations.

---

*Read before the American Institute of Chemical Engineers, Cambridge, Mass., June 20, 1919.

During 1917 it became apparent that the vertical retort plant had reached the end of its useful life, and various plans were considered for replacing it with coal carbonizing equipment. It was finally decided to build a battery of 40 Koppers combination gas and coke ovens, which would give a nominal generating capacity of 7,000,000 cu.ft. per day, capable of making at least 10 per cent more gas than their rating, if desired. The construction of this plant was started early in 1918 and gas was first made the latter part of January, 1919.

At the present time the Providence Gas Co. is equipped with a water gas plant which can easily generate 9,000,000 cu.ft. of gas per day and with a coal plant generating up to 7,750,000 cu.ft. per day. As the present output is in the neighborhood of 2,250,000,000 annually, with a maximum daily output of 9,300,000, it would appear that no further extensions of the plant should be necessary for years to come.

All buildings and practically all apparatus now used in generating gas were new within the last ten years and represent in every respect the most up-to-date and modern practice in the United States. It is proper to say that the Providence Gas works is the model gas plant of New England, if not of the United States.

COAL GAS WORKS OF 1910

The first plant to be erected at Sassafras Point was the Dessau vertical coal gas works, which was built under the supervision of the gas company's engineer, Mr. Carroll D. Miller, who has described the construction and operation of this plant in papers before the New England Association of Gas Engineers and also the American Gas Institute, from which papers I have liberally drawn for the information given herewith.

COAL STORAGE PLANT

A sea wall of stone masonry was constructed and has since been extended to be about 600 ft. long, and there is a depth of about 28 ft. of water at high tide, which will accommodate all ordinary coal barges and some of the large capacity steamers. For unloading coal from barges and delivering to the storage pile or storage shed, a coal bridge (Fig. 1) was erected by the Brown Hoisting Machinery Co. This coal bridge has a capacity of 100 to 150 tons per hr., depending on the conditions. Coal is picked up with a 2-ton clamshell bucket. One leg of the coal bridge runs on the sea wall, the other leg on rails close to the coal shed, with a 211-ft. span. The trolley handling the clamshell bucket has a travel of 304 ft. and the total length of the bridge is 324 ft., including overhang. The clearance of the bucket from the ground is 56 feet.

The bridge can travel in longitudinal direction 600 ft. Coal can be unloaded with this bridge from barges to the storage pile and then rehandled into the shed, or it can be handled by the bridge from barges into the shed, or it can be dropped directly into the hopper feeding the coal crushers and belts to the retort house.

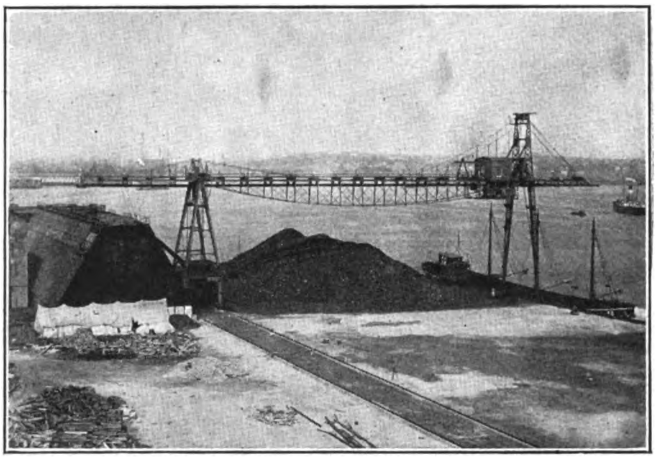


FIG. 1. COAL BRIDGE AND COAL STORAGE HOUSE

At the north end of the storage ground is an open bin of 1000 tons capacity, which is now being used for buckwheat boiler fuel. Adjacent to this is a space reserved for 10,000 tons of broken anthracite for water gas generation. The rest of the storage space is divided up between high volatile and low volatile coking coals with storage capacity of a total of about 60,000 tons.

Coal Shed—The coal storage shed was arranged to store a maximum of 8000 tons of coal under cover.

The framework of the shed is constructed of "A" steel frame bents, the bents being designed to carry the sides, roofing and tracks of the main trolley, which is used for reclaiming the coal from the storage shed and passing same into the hopper over the crusher.

The bottom of the coal shed and foundations of the steel frame are of concrete. The roof over the shed is provided with movable sections or hatchways, so that the storage bridge may deposit coal into any portion of the shed. This storage shed was originally used for gas coal for the retort house but is now used for storing bituminous coal for use in the producer gas plant. The reclaiming is done by means of Dodge telphers, having 2-cu.yd. buckets.

RETORT HOUSE

The retort house, which was built entirely by the Didier-March Co., is of German design. The building is 85 ft. wide, 215 ft. long and 59 ft. high to the ridge. The roof is open in the center to give the greatest possible ventilation, combined with louvres placed in the side walls of the house. There were also provided 28 double sliding doors to make the house easily accessible from all sides and 74 windows. A platform was constructed in front of each stack at the height of the bottom of the retorts and another platform in front of the hydraulic mains, with an operating floor around the tops of the benches. The roof was constructed of graduated reinforced asbestos sheets fastened to channel purlins with aluminum wires.

Coal Handling—A steel hopper receives the coal from the telpher or bridge, dropping it into a weighing hopper and thence the coal goes onto an apron feeder, which carries the coal to jaw crushers. From the jaw crushers, bucket elevators carry the coal to the top of the retort house. These bucket elevators have 66-ft. centers and are made up of No. 10 steel "V" shaped buckets measuring 20 in. by 50 in., driven by motors. The bucket elevators discharge onto belt conveyors having 200-ft. centers, which deliver the coal from the elevator to the coal bins. This belt is 18 inches wide

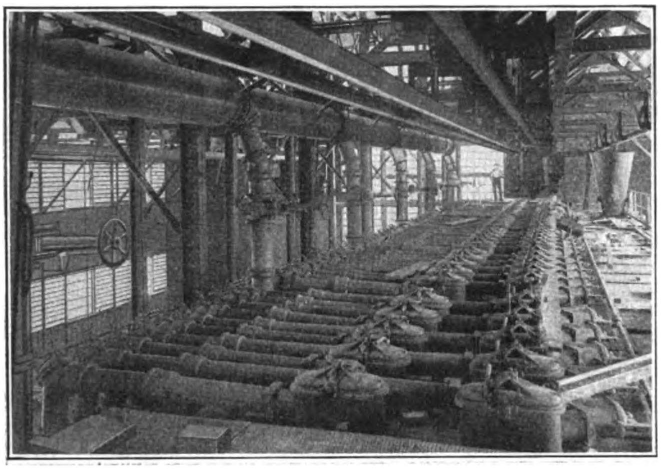


FIG. 2. TOP OF BENCHES

and is provided with a self-propelling automatic reversing tripper running on rails, which discharges the coal automatically over the entire length of the coal bin. Each of these coal bins has a capacity of 260 net tons and is constructed of steel plates properly stiffened. Each bin is provided with a series of discharging valves of the swinging undercut type. At the present time, as the retort house has been abandoned for generating coal gas, the north bin is not in use. The south bin is now used for the fuel for the producer gas plant, which furnishes the gas for heating the coke ovens.

Benches—Four stacks of vertical benches were erected, three consisting of six benches of ten retorts each, the fourth consisting of six benches of fifteen retorts each. In the benches of 10's, the retorts measure 22½ in. by 9 in. at the top and 27 in. by 14 in. at the bottom and are 13 ft. 2 in. long. The recuperating system is located on both sides of the generators, consisting of a system of primary and secondary air flues and adjacent to a series of waste heat flues which convey the products of combustion to the lower portion of the benches. (Fig. 2.)

The generators were located on one side of the benches adjacent to the retorts and the producer gas entered the main oxide flue through two openings about 3 ft. above the grate bars. The coke charging openings are located some 14 ft. above this point on a level with the retort operating floor, this space serving for coke storage.

VAPORIZERS

A vaporizer for each generator was located underneath the ash pan and vaporization was effected by the products of combustion before entering the main smoke flue. The vapors produced were conducted under the grate and thoroughly mixed with the heated primary air. A separate main smoke flue 3 ft. square was provided for each stack connected to a chimney outside the building. Four chimneys were erected of hollow radial molded blocks of the Custodis system and are 125 ft. high with 4 ft. inside diameter at the top.

The lower mouthpieces were operated from the outside of the benches by means of a system of levels, racks and pinions. A separate hydraulic main was provided for each bench. These hydraulic mains were sealed only during charging of the retort, which was accomplished by means of a weir valve, which was raised shortly before charging time and which allowed the circulating liquor to fill up and seal the dip pipes. Underneath each dip pipe was placed a pitch pan, which could easily be removed for cleaning. Two foul mains, one on each side of the house, carried gas to the end of the building and thence to the underground foul main.

CHARGING THE GENERATORS

For charging the generators with coke, a steel plate hopper was used, running on a monorail. Before charging coal into the retort, the bottom of the retort was filled with a small amount of coke breeze by means of a traveling breeze hopper. This was followed by the coal-charging hopper, which was constructed to charge two retorts simultaneously on the benches having ten retorts and three retorts on the benches having fifteen. The coke which discharged from the retorts fell into a movable chute, which brought the coal over to a De-Brower hot coke conveyor located in front of the stacks. (Fig. 3.) Originally the conveyor discharged into a skip hoist, which elevated the coke into a night storage bin, but this system was found unsatisfactory and was changed to deliver the coke into a second conveyor, which, in turn, carried the coke to concrete pits. Just outside of the retort house was a set of water sprinklers, which quenched the hot coke, the steam being carried away by a vertical flue.

The fourth stack of benches to be erected was built with fifteen retorts to the bench, which was thought to give some economies in operation. The retorts were 19⅝ in. by 9¾ in. at the top and 24⅜ in. by 14⅛ in. at the bottom, having the same length of 13 ft. 2 in. The other constructional details were similar with the exception of the method of handling the lower mouthpieces, which were handled by hydraulic valves rather than by hand, which was an immense improvement. Also the steam vaporizers were omitted and step grates were used instead of bar grates. Step grates were also used on the third stack to be built.

The coke which was quenched by the water sprays and carried by a second chain conveyor passed over a grizzly, where a large part of the breeze dropped out, and then fell into concrete pits, whence it was handled by telphers.

A telpher system with a clearance of 54 ft. above ground level handled the coke from the pits to storage or to the screen houses. These telphers were later extended to handle coke to the water gas plant and also

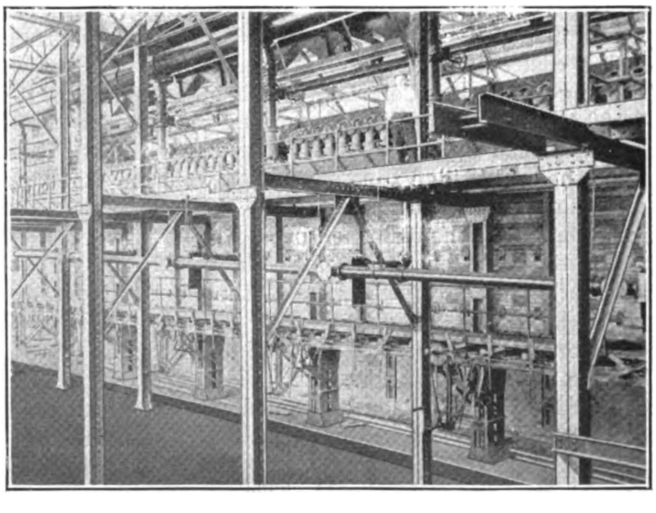


FIG. 3. SIDE VIEW OF BENCHES

anthracite for the water gas plant and coke breeze or other fuel for the boiler plant and, at the time of completing the coke oven plant, they were still further extended to take care of the coke from the ovens.

The coke was handled to storage and to the shaker screen houses with 2½-ton clamshell buckets.

CONDENSING PLANT

Buildings—At the time this plant was built, it was common practice to house all condensing plants. In the past few years, the use of outdoor condensing plants has grown rapidly in favor. The condenser house is 45 ft. wide by 120 ft. long and about 30 ft. high, with brick walls carrying steel roof trusses. The roof is of terra cotta hook tile covered with slate with a monitor extending the whole length of the building, having pivoted sash. Concrete floors are provided throughout.

Condensing Equipment—The condensing plant as originally constructed consisted of two primary condensers, two exhausters, two tar extractors, two secondary condensers, two rotary ammonia scrubbers. Later a Feld washer was constructed to assist in ammonia recovery.

The primary condensers are rectangular water tube condensers, having 3200 cu.ft. effective cooling surface each. The combined capacity of these two condensers is 3,000,000 cu.ft. per day. Following the primary condensers is a duplicate installation of Connersville exhausters, having a capacity of 17 cu.ft. per revolution, and equipped with Isbel-Porter governors. Tar extraction is provided for by two Bartlett-Hayward P. & A. tar extractors with a single submersion chamber, the shell being of cast iron. There are two of these tar extractors and each of them has a capacity of 3,000,000 cu.ft. per day.

Following the tar extractors are two secondary rectangular water tube condensers, each having an effective surface of 6000 sq.ft. (Fig. 4.) The water used on the secondary condensers passes to the primary condensers. The temperature of condensation is controlled by Tagliabue regulators.

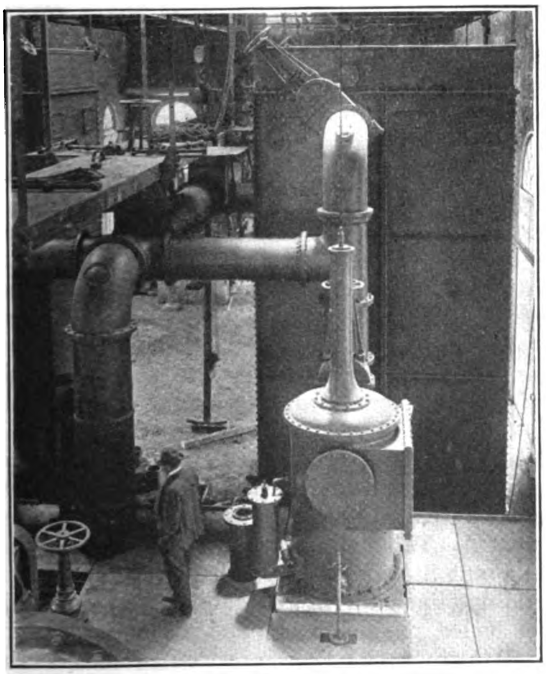


FIG. 4. SECONDARY CONDENSERS

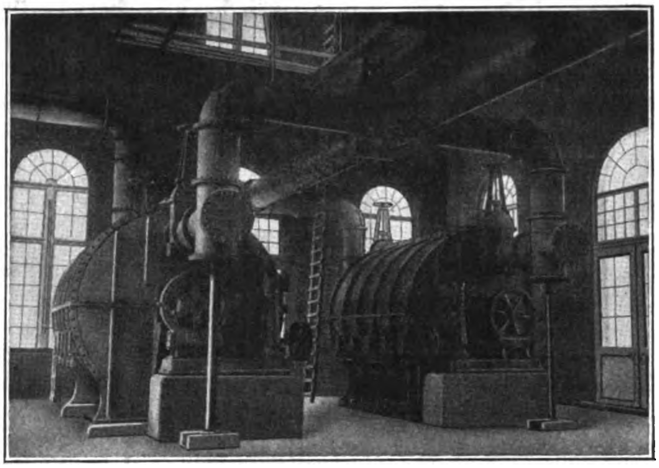


FIG. 5. ROTARY SCRUBBERS FOR FINAL REMOVAL OF AMMONIA

A 5-ft., 7-section Feld washer serves as a primary ammonia scrubber and has developed into a very useful apparatus, for the removal of hydrogen sulphide, in combination with ammonia in the liquor from the secondary scrubbers.

FINAL REMOVAL OF AMMONIA

The final removal of ammonia was secured by two rotary scrubbers (Fig. 5) constructed in five days, having a diameter of 10 ft. The washing surface is composed of standard wood grids, the washer being supplied with a small engine directly connected to a worm operating on the worm wheel attached to the shaft. All connections in the building are 24 in. diameter straight pipe made of steel plates, all fittings being made of cast iron.

The tar and liquor from the retort house run into an underground concrete system 20 ft. by 45 ft. by 10 ft. in depth, where the tar and liquor condensed in the retort house are separated. The weak liquor collected at this point was used for sealing the hydraulic mains and finally found its way to the main ammonia liquor storage. The tar collected in the separator was pumped to an overground steel tank located near the retort house.

Alongside the condenser house there is an underground concrete ammonia tank measuring 35 ft. by 120 ft. by 10 ft. in depth, wherein is received and stored all the tar and liquor collected from the condensing and purifying plants. The tar separated at this point was sent to the overground tar tank and the ammonia delivered to the ammonia works.

PURIFYING PLANT

Buildings—The purifier house is 110 ft. long by 61 ft. wide and 36 ft. high and accommodates four purifiers. The building is of steel frame, the space between the frames and around the outside of the columns being built of brick. The roof is covered with hook tile carrying slate. A stairway leads from the ground floor to the operating floor around the boxes. This operating floor is built of steel plate. The roof is provided with a monitor extending the whole length of the building carrying a monitor sash. The general design of the building is similar to that of the other plant buildings, having granite trim and general handsome appearance. The purifying boxes measure 40 ft. by 20 ft. by 10 ft. deep and contain three layers of oxide with valve connections to provide a triplex flow of gas. (Fig. 6.) The covers of the boxes are supplied with rubber lutes and holding down clamps and are handled with an overhead traveling crane. The system of valves and fittings is arranged so as to work the boxes either in forward or backward rotation.

In dumping a box, the oxide is dropped through openings in the bottom of the box onto a concrete floor. In filling a box, the wheelbarrows of oxide are raised to the operating floor by a Craig Ridgway steam hydraulic elevator.

METER HOUSE

From the purifying plant, the gas passes underground in a 24-in. main to the meter house, which is 40 ft. by 45 ft. by 20 ft., constructed of brick with steel roof trusses, the roof being of hook tile carrying slate. Space is provided in this building for four meters. When the coal gas plant was built, one 14-ft. meter was installed by the Nathaniel Tufts Meter Co., and supplied with a Hinman drum. A photometer room was also constructed in the space provided for one of the future meters.

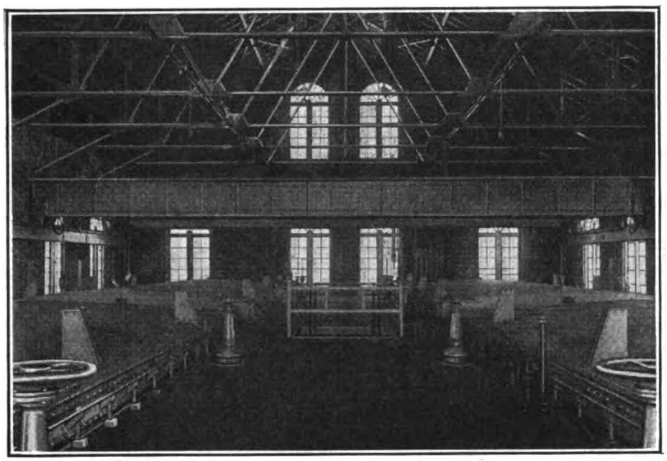


FIG. 6. COAL GAS PURIFIER BOXES

POWER PLANT

The power plant is housed in two buildings; one containing the boilers and the other containing the engines, generators and auxiliary machinery. The boiler house is 88 ft. by 65 ft. by 30 ft. high, of the same general construction as the other buildings on the plant. When first built three B. & W. 440-hp. boilers were installed, equipped for hand firing. A radial brick chimney was provided and additional forced draft was secured by means of an engine driven Sturtevant fan. An open-feed water heater was provided for the boiler water, but for the first few years very little exhaust steam was secured and the temperature of the water entering the boilers was never very high.

Engine House—The engine house is 46 ft. by 90 ft. and contains a main operating floor and basement. On the main operating floor are two 300-kw. cross compound, direct connected Allis Chalmers engines and generators. (Fig. 7.) These engines run condensing, utilizing salt water from the bay to operate barometric condensers. A 250-volt d.c. electric current is generated and is distributed through a switchboard to various circuits in the plant. Electric power is utilized for all possible operation of machinery.

In the cellar of the engine house are located the centrifugal boiler pumps, the condensing pumps and the fire pump, which utilizes salt water from the bay.

Water Tower and Wells—There are three sources of water supply for the works. Water from the city mains is used for boilers and other purposes where pure, fresh water is required. A set of driven wells was put down to a depth of about 50 ft., tapping underground veins of water, which some time after their construction unfortunately became contaminated with salt water from the bay. These wells are provided with two Davidson electric pumps, delivering the water into a tank on a tower, the tank having a capacity of 100,000 gal. of water and being elevated about 80 ft. from the ground.

RESULTS IN OPERATION

The coke made in this plant was of a very superior quality and found a ready sale for all domestic purposes. The yield of gas, tar and ammonia was satisfactory. When the plant was first started, it was very economical as to labor, but conditions later developed which caused the labor account to be high.

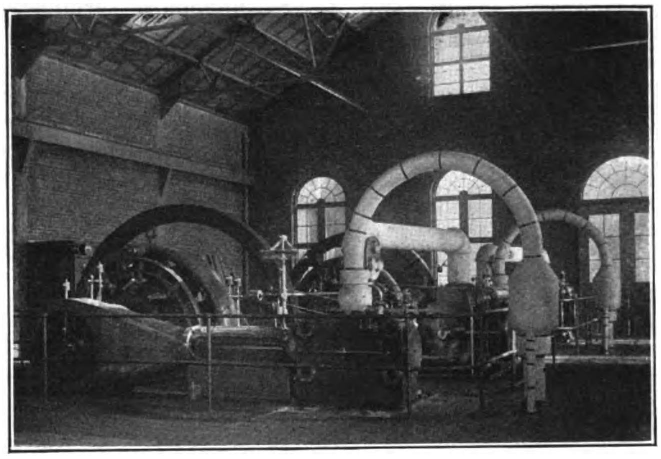


FIG. 7. ENGINE ROOM

This was the pioneer plant in America of Dessau vertical retorts, which accounts for many of the operating difficulties encountered. There are now several very successful installations of vertical retorts on the Dessau system wherein American conditions have been more thoroughly taken into account.

WATER GAS PLANT

During the year 1915, it became evident that the capacity of the South Station for generating water gas would soon be exceeded by the demand, and it was decided to build a complete new water gas plant at the Sassafras Point Station. In July, 1915, the Bartlett Hayward Co. of Baltimore presented plans and specifications for this plant, which were accepted, and construction was commenced, gas being made in the new plant about the first of December, 1916. Mr. R. E. Slade had succeeded Mr. Carroll Miller as engineer for the gas company, and it was under his direction and supervision that the water gas plant was planned and constructed. The manufacture of water gas at the Sassafras Point Station involved the erection of a number of buildings, including a generator house, engine house, washer house, purifier house and a set of coal and coke bins. It also involved the erection of a relief holder, two oil tanks, extension of the boiler capacity, extension of telpher lines, the moving of two station meters from the South Station to the new plant and also a 500,000-gal. tar tank. (Fig. 8.)

With the exception of the water gas machines, which were furnished and installed by the United Gas Improvement Co., all of the construction was undertaken by the Bartlett Hayward Co., although apparatus from several other firms was specified for certain purposes.

COAL AND COKE HANDLING

Adjoining the generator house and located between the generator house and the boiler house, a set of coal, coke and breeze bins was erected. These bins were about 120 ft. long and 23 ft. wide and were constructed of steel plates stiffened with steel beams supported on "H" columns roofed over with asbestos-protected metal. A steel partition runs lengthwise through the bunkers, so that boiler fuel may be separated from water gas fuel. In addition to this, wooden partitions were later put in, so that water gas coal and water gas coke could be separated and also different varieties of boiler fuel could be kept separate.

There are steel chutes with undercut gates serving the boiler house and the operating floor of the water gas plant.

Anthracite which is stored on the waterfront is delivered into the north end of the coal storage shed by the coal bridge. The telpher lines were extended to serve this coal store and coal is brought by telphers to a new hopper, which also takes coke, breeze and boiler coal handled by telphers from their respective storage piles. This hopper delivers to a motor driven 30-in. belt, having 205-ft. centers, with a capacity of forty tons per hr., which conveys the fuel up an incline to the proper elevation, then horizontally above the bins to the end of the bin house. A traveling unloader runs on rails above the bins and discharges the fuel where desired.

BUILDINGS

The generator house is of steel frame construction, the roof being carried on steel purlins and trusses, the trusses spanning the entire width and being supported on steel columns securely anchored to the building foundations, so that all loads are carried independent of brick side walls. A steel frame monitor, carrying swinging windows, is constructed on the roof. The end walls are carried up above the ends of the roof and are capped with stone. This building is 217 ft. long, 71 ft. wide and 31 ft. 10 in. high from the ground floor to the bottom chord of roof trusses. This building was so laid out as to accommodate five sets of water gas generating apparatus, but to date three sets only have been installed.

The exhauster and pump house is 60 ft. long by 41 ft. wide and is of the same general construction as the generator house. The operating floor for the engines and exhausters is slightly above grade, and a pump room is provided somwhat below grade. Space was provided for three exhausters, only two being installed at present.

The tar extractor and washer house is 41 ft. long, 37 ft. wide and 21 ft. high. It has 13-in. brick walls with stone trim, the roof being carried on steel trusses anchored to 17-in. pilasters. There is a monitor on the roof with pivoted sash.

The purifier house is of steel frame construction with brick filled sides and gable roof, the roof being carried by steel purlins and supported by trusses carried on steel columns. An outside steel stairway runs to the purifier floor. There is an additional stairway inside the building. The dimensions are 112 ft. by 61 ft. inside and 44 ft. 6 in. high from the ground floor to underside of roof trusses.

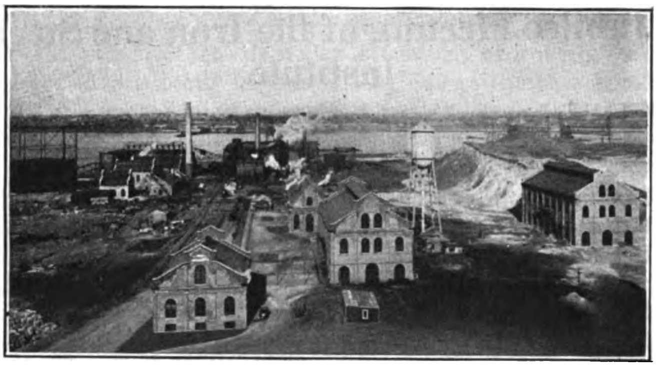


FIG. 8. GENERAL VIEW SHOWING ORIGINAL COAL GAS PLANT AND WATER GAS PLANT ADDED IN 1915

The roofs of all building are of terra cotta hook tile laid in cement with slate covering. All buildings are substantially built and have a handsome appearance.

EDITOR'S NOTES: This article is to be continued. Part II will describe in detail the new water-gas plant and Part III the Koppers combination-gas ovens.

Industrial Alcohol Act

At the present time industrial alcohol manufacturers are subjected to practically all the restrictions that are imposed upon the distiller of whiskey, with the result that production costs are unreasonably high.

To meet this situation, the Internal Revenue Bureau has drafted a bill, H. R. 5029, which is designed to make it possible for the Secretary of the Treasury and the Commissioner of Internal Revenue to relieve distillers of industrial alcohol from unnecessary and costly supervision in order that industrial alcohol may be made at minimum cost.[1]

This bill provides for the registration, bonding and licensing of plants and warehouses for the manufacture, storage and distribution of alcohol which is to be used exclusively for non-beverage purposes. Those plants which are producing industrial alcohol exclusively at the present will be required to apply for registration within thirty days after the passage of the act. Legally established distilleries or bonded warehouses may also apply for permits to operate as industrial alcohol plants and warehouses. The alcohol may be produced from any raw materials and by any suitable process.

Such alcohol is subject to taxation but, by filing application and bond and obtaining a permit, a denaturing plant may be established at any industrial alcohol plant, and the denatured product sold free of tax for domestic or foreign use. Undenatured alcohol may be withdrawn, tax free, for the use of any university, research laboratory, or any hospital not conducted for profit.

The industry is to be regulated by the Commissioner of Internal Revenue (with the approval of the Secretary of the Treasury) in such manner that an ample supply, produced under the most efficient conditions, shall be available for scientific research and the development of fuels, dyes and other products.

---

[1] Testimony of Deputy Commissioner Gaylord of Internal Revenue Board at hearing before the House Judiciary Committee.

Jubilee Meeting of the Iron and Steel Institute

THE Iron and Steel Institute (British) held its fiftieth annual meeting in London on May 8, 1919. The secretary reported the total membership of 2098. During the preceding year four new applications were received for grants of £100 each from Andrew Carnegie Research Fund, as follows: S. L. Hoyt, Minneapolis, for an investigation on the foreign inclusions in steel; J. N. Kilby, Sheffield, for an investigation on the basic open-hearth process, including its chemistry; G. Patchin, London, for research upon semi-steel and its heat treatment; J. A. Van den Broeck, Ann Arbor, for a continuation of studies on the effect of cold-working on the elastic properties of steel.

The Bessemer medal was presented to M. Leon Greiner.

The technical program contained a large number of excellent papers of which we present the following synopsis.

NATURE OF TRANSFORMATIONS IN IRON

A review of the evidence regarding the nature of the various transformations in iron was presented by Prof. K. Honda of the Imperial University, Sendai, Japan, "On the Non-Allotropic Nature of the A_2 Transformation in Iron." Regarding the change in physical properties with change in temperature as being due to variations in amplitude of atomic vibrations, an allotropic change occurs when these thermal vibrations exceed the limits of equilibrium of the then existant structure, and a new atomic configuration results. Since all changes take time, real allotropic transformations may spread over a considerable temperature range, and are difficult to distinguish from non-allotropic variations of physical properties as to temperature. However, the criterion of the latter is that the property of a substance bears a fixed relation to the temperature, unchanging with time, whereas allotropy is a transformation which proceeds at a definite temperature, if a sufficient time be allowed.

For pure iron there have been shown to be two real transformations, A_3, occurring at 893-898 deg. C. (3 hours' time being required) and A_4 occurring at 1385-1390 deg. (but a few minutes being required). A_2—the magnetic transformation—on the other hand, begins at ordinary temperatures, its rate of change increases with temperature until at 785 deg. C. the test piece changes from the ferromagnetic to the paramagnetic state. An explanation of such changes is given, based upon the molecular theory of magnetism; wherein the author concludes that the A_2 transformation is not truly allotropic, but is the process of requiring the rotational energy of molecules, whose amount is a definite function of temperature.

In the case of carbon steels, there are two other transformations. A_1, at 700-750 deg. C. is the eutectic transformation of cementite and ferrite, proved to take place at definite temperatures if the rate of heating or cooling is sufficiently slow, and therefore an allotropic change of phase. A_0 at 215 deg. C. is the critical point of cementite and is of exactly the same variety as A_2—that is, non-allotropic.

A. Cesáro, of Liège University, presented a "Note on the Liquidus in the Iron-Carbon Diagram." On the assumption that the liquidus should be a straight line, the author shows mathematically that absolute rectilinearity cannot be obtained when using numerical values obtained by Carpenter and Keeling on any supposition as to the number of atoms of iron in a liquid molecule. He also shows that the nearest approach to plus or minus 8 deg., or within the experimental error, is when the iron molecule is regarded as Fe_2 and the melt assumed to consist of $Fe_3C \cdot Fe_2$ rather than of $F \cdot C$. Raoult's law, which leads to a straight line, presupposes dilute solutions of alloys not forming solid solutions upon solidification, neither condition being satisfied in the iron-carbon diagram. The author then applied the more general law to the Le Chatelier-Schroeder.

$$\ln z = \frac{Q}{2}\left(\frac{1}{T_0} - \frac{1}{T}\right)$$

where temperatures are expressed above absolute zero, and z is atomic per cent of solvent (gamma iron). Computing theoretical values of melting points T and comparing them with values observed by Carpenter and Keeling shows a much wider divergence than those found by Raoult's law, but as before a better agreement on the assumption that the melt consists of molecules of Fe_3C and Fe_2.

MACRO-ETCHING AND MACRO-PRINTING

It is often very desirable to develop and print the macro structure of large steel sections for purposes of study and comparison. J. C. W. Humfrey, of the Inspection Service, describes a novel method of doing this in his paper "Macro-etching and Macro-printing." Sulphur printing on silk or silver bromide paper reveals the major segregates excellently, but the minor segregation—that occurring within the boundaries of the original crystal—is not revealed unless sulphur is very high. Besides, very great care is necessary to avoid movement during printing and insure uniform contact. Strong (10-20 per cent) solutions of hot HCl or H_2SO_4 act upon sulphide inclusions in much the same way, and require high sulphur metal for good results. Heyn's reagent (12 per cent $Cu\ (NH_3)_2\ SO_4$) is hardly sufficient to reveal minor segregations of phosphorus. Solutions of nitric acid are particularly useful for revealing fine flaws, which show after deep etching by a slight oozing when the surface is wiped clean and carefully dried with alcohol. It is very delicate in revealing locally decarburized areas, especially while the acid is still attacking. Acid cupric reagents are remarkably sensitive, but the surface should first be given a fine polish. At best any of these later methods must be photographed for record, which, in the case of large sections, will involve a reduction in scale.

Humfrey finds that a reagant such as

$Cu(NH_3)_2SO_4$	120 g.
Conc. HCl	50 cc. (more or less)
H_2O	1000 cc.

is as delicate as any previously recommended, and can be used for very deep etching of a machined surface, after which it can be printed like a type-form on a proof press or in a letter-copying press. Etching is best done on the surface supported horizontally, starting with Heyn's solution, etching deeply to eliminate tool marks and surface hardening and then continuing with the new acid solution by pouring on fresh additions at intervals. Deposited copper can readily be wiped off; in case examination reveals insufficient attack, it should be resumed first with the neutral reagent. The strong relief is brought out by light buffing. To print, merely ink with a proof roller, place on the bed of a copy press, cover with "glossy art paper," overlay with two thicknesses of broadcloth, and apply pressure.

This solution acts by attacking the purer portions which solidified first with greater vigor, leaving in relief the major and minor segregates, which thus print black on the proof. Some very beautiful examples of work on shell forgings are illustrated in the original paper.

GRAPHITIZATION IN IRON-CARBON ALLOYS

Whether graphite or cementite is the stable constituent of pure iron-carbon alloys was again discussed by K. Tawara and G. Asohara of Tokyo University. They cast a number of triangular ingots, in preheated clay molds, and studied the effect of six variables with regard to graphitization. First, chemical composition (that is to say, carbon content, the amount of silicon being held at 0.05 per cent or less, while the other impurities were very low) appeared not to be a decisive factor in graphitization. Graphite was always seen in a slowly cooled ingot containing from 2½ to 3½ per cent carbon, although in relatively larger amounts in higher carbon irons, which would be expected if the constituents appearing at primary solidification were austenite and graphite only. Second, the maximum temperature attained by the molten iron appeared to have no effect. Thus no excess decomposition of Fe_3C by superheating appeared to persist at the liquidus. Third, temperatures of casting up to 1400 deg. C. for a 3.3 per cent C appeared to cause no differences. Fourth, temperature of the mold had a large effect due to the speed at which it cooled the metal through the solidification range. Thus no graphite was found after pouring in a mold heated to 900 deg. C., held for 7 hr. at that temperature and then quenched. When cast in a mold heated to 1000 deg. C., held for 8 hr. and then quenched, graphite appeared in spots only. When cast in a mold heated to 1100 deg. C., held for 1½ hr. and then quenched there was plenty of graphite. However, the same procedure in a mold at 1125-1128 deg. C. gave no graphite. The authors interpret the last results as meaning that the metal (3.3 per cent C) was held liquid in the mold, and when quenched it was white iron; a mold at 1100 deg. C. giving an optimum cooling rate through the mushy stage for graphitization. Fifth, when the mold is 1100 deg. C. and the subsequent cooling is slow, the metal is completely graphitized independently of the time it is held at 1100 deg. C. Sixth, with a mold at 1100 deg. C., the speed of subsequent cooling merely affects the method of deposition of the primary austenite, water quenching producing martensitic ground mass, and slow cooling producing pearlite and needle cementite.

From these experiments the authors conclude that homogeneous graphitization takes place during the slow cooling of the metal down to 1100 deg. C., covering a time longer than 30 min., and when uninfluenced by such accelerators as silicon and manganese, does not occur at 1000 deg. C. even after 8 hours' uniform heating. Consequently they believe that cementite in the melt is at least partially dissociated, and if time be given during solidification, the free carbon thus in existence will crystallize as graphite particles causing more cementite to decompose, enriching the melt in ferrite, the contemporaneous product of dissociation, when finally the remaining melt will have the composition of saturated austenite. Thus is the stable alloy produced. On more rapid cooling, decomposition of molten cementite is incomplete, whence the metastable "mottled" iron. The authors consider a graphite crystal as being an element of the eutectic; the lamellar structure ordinarily expected of a eutectic is thus absent due to the slow cooling of the melt. Such crystals are surrounded by resolved austenite (needle cementite plus pearlite), as they should be, and not by ferrite resulting from a hypothetical decomposition of Fe_3C.

INFLUENCE OF RATE OF COOLING ON HARDENING CARBON STEEL

"An Experimental Investigation of the Influence of the Rate of Cooling on the Hardening of Carbon Steels" was described at considerable length by the prominent French metallurgist, A. M. Portevin of the Ecole Centrale des Arts et Manufactures, Paris, and his associate, M. Garvin. In a preliminary part the authors describe in detail their apparatus and method of tracing cooling curves at very rapid rates. A platinum couple whose elements were but 0.1 mm. in diameter was used in order that its heat capacity be negligible, and actual contact at the center of the cylindrical test piece was periodically verified by measuring the resistance, couple to specimen. In order that this contact might not be disturbed, the specimen and couple were both held stationary by a nickel-steel tube fixed to the upper head of a standard. Heating was done by a Meker blast lamp; when a predetermined temperature was reached the lamp was rapidly lowered, a quenching cup swung into place, and the specimen was cooled by a uniform flow of water. Automatic records were made photographically by a beam of light from a galvanometer mirror; the paper contains information as to necessary precautions and corrections to insure proper time and temperature registration.

Their problem was to determine for a given steel how the transformations, structure and hardness vary with different rates of quenching (τ from 700 to 200 deg. C. was the unit of comparison) and the initial temperature of quenching. Different speeds of quenching were had by using geometrically similar specimens of varying diameter; after quenching the pieces were broken across their center and the microscopy and Brinell hardness of the spot directly in contact with the thermocouple junction examined. A series of such curves for 1.07 C steel is illustrated in Fig. 1, and it is seen that rapid cooling suppresses transformations until 300 to 350 deg. C. Such cylinders are entirely martensitic and their hardness is uniformly close to 600. On cylinders 14 mm. in diameter and larger, however, this lower transformation Ar″ is suppressed and an upper one, Ar′, at

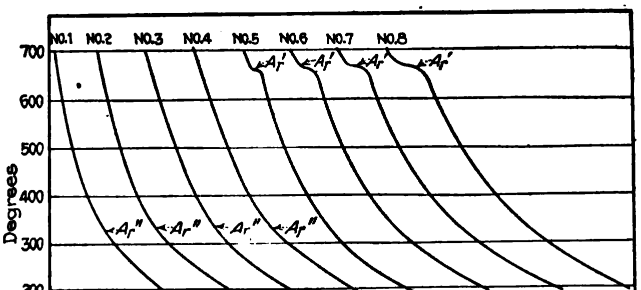


FIG. 1. AVERAGE COOLING CURVES AT THE CENTERS OF GEOMETRICALLY SIMILAR CYLINDERS OF STEEL CONTAINING 1.07 PER CENT CARBON AND 0.08 PER CENT MANGANESE, QUENCHED IN WATER

635 to 665 (depending upon the speed) appears. Such cylinders show uniformly a troostitic core, of hardness, 400, surrounded by a shell of martensite of thickness decreasing as the diameter increases. There is therefore a critical range in the rate of cooling (in this particular steel, about 7 sec. from 700 to 200 deg. C.) at which the interval transformations suddenly change their nature and position on the temperature scale. When quenching at speeds near this rate, the same steel will sometimes appear troostitic, sometimes martensitic, and sometimes both Ar′ and Ar″ are in evidence, giving a martensite-troostite complex.

Experiments by the authors demonstrate that composition has much to do with the critical rate. Particularly manganese will increase the critical time between 700 and 200, imparting quasi self-hardening properties. Variations in carbon also appear to have a marked influence. Eutectoid steels have slow critical rate as compared with either hypo-eutectoid or hyper-eutectoid, either of which tends to become troostitic with the separation of the pro-eutectoid constituents, ferrite or cementite respectively. This excess constituent may well be the cause of the phenomena, presenting nuclei unabsorbed into the austenite around which crystallization proceeds, correspondingly inducing formation of troostite. Unabsorbed nuclei may be the reason why previous heat treatment, mechanical working, method of manufacture, duration of heat and temperature of quenching all have an effect upon the speed of quenching.

In particular, raising the quenching temperature in the neighborhood of the critical rate tends to make Ar′ disappear, as does also a second quenching. Also the authors point out that various facts already determined about quenching hold true at rates somewhat distant from the critical—thus τ varies as diameter of geometrically similar cylinders except at the critical rate, nor does hardness vary as the temperature of quenching (except at the critical rate), and with the same provision, the agitation, rate of circulation, or temperature of cooling water will not affect the hardness of drastic quenchings. By interrupting the quenching at various temperatures, the authors were also able to form troostite (γ iron-carbon solution $\longrightarrow Fe_3C + \alpha$ iron complex) at temperatures as slow as 400 deg. Strong recalescence is exhibited in such curves, and microscopically the troostite is strongly marked and bulky, both the characteristics of a sharply defined reaction, much different from that which occurs when annealing martensite to troostite, osmondite or sorbite.

TWO PAPERS ON TOOL STEEL

"The Manufacture and Working of High-Speed Steel" was described in a paper by J. H. Andrew and G. W. Green of the Metallurgical Research Dept., Armstrong, Whitworth & Co., wherein they gave the practice at the Openshaw works in manufacture of steel bars with 14 per cent W, 3.8 per cent Cr, 0.5 per cent V, and 0.6 per cent C. Such material is melted in crucibles, and poured at 1420 ± 20 deg. C. into ladles, wherefrom it teemed at 1335 ± 5 deg. C. into chills, making a top-cast ingot 6 in. square and weighing 350 lb. After 30 min. the ingots are stripped, being then at 650 deg. and annealed in a gas-fired furnace for 48 hr. at 800 deg. C. Microsections now show excessive carbide segregation at the skin, and fine structure at the outer portion of the ingot. In the center is coarse-grained structure with thick walls of carbide.

Drillings from various parts of the ingots and croppings show practically no measurable segregation. This. as well as the entire absence of blowholes. is probably due to the small size of ingot, and the very quick solidification, due to the chill-mold and high alloy content.

Mechanical and heat treatment are resorted to in order to reduce this crystalline structure to an extremely fine grain, it having been found that 88 per cent reduction is necessary before the distorted carbide envelopes lose their dangerous form of loops and hooks. Whether reduction is done by rolling or forging is immaterial, as long as the working temperatures are correct, which, by the way, are greater than generally thought to be correct.

A good practice is cited as folows: After annealing, the ingots are preheated, attaining 820 deg. C. in 24 hr., then transferred to another furnace and brought to 1170 deg. in 4 or 5 hr. Cogging from 6 to 3½ in. square was done under a 1½-ton hammer, occupying about 4½ min., at which time the temperature was 1000 deg. C. Ten per cent of the head was cropped off; and any surface cracks gouged out with a steel tool, as is done after each reduction. Microsections now show well disseminated carbide in the outer portions, but at the center the envelopes are merely distorted.

After the 3½-in. billets are cut in half, they are aired under the fire-bars and finally charged into a cool-fired furnace, attaining a temperature of 1150 ± 20 deg. C. and soaking until the forge is ready for them. Forging one end to 1⅝ in. requires slightly less than 2 min., during which time the temperature falls 50 deg. The large end is reheated and drawn under the same conditions. Microscopically, the carbide now is in laminated, band-like zones, occasionally appearing as semi-decomposed austenite.

From 1⅝ in. the bars are tilted or rolled to 1¼ in., rolling starting at 1030 deg. C. and requiring 15 to 18 passes, consuming nearly 2 min., the temperature dropping about 10½ deg. per pass. Tilting is done on each end separately as before, requiring about 2 min., during which the temperature drops from 1100 deg. to 850 ± 50 deg. At this point the carbide envelopes are broken up into grains, but these still assume laminated arrangement as to position.

In older practice the 1¼-in. bars were then annealed by heating to 800 deg. C. in 24 hr., then damp the furnace from 3 to 6 hr., when the bars were furnace cooled during 36 hr. This required 3 days, and the structure was not refined (800 deg. being lower than the transformation range). Newer practice heats slowly to 900 deg. C., soaking a little time, cooling in furnace to 700 deg. C., and cooling in air. Cast structure is now eliminated, the bars have been softened from Brinell 616 to 250, and are ready for shaping into machine tools.

Lathe tools are hardened by gradually heating to a medium red heat, then quickly heating the nose to 1290-1300 deg. C., when it is quickly withdrawn and cooled in air-blast or oil attaining Brinell 650. Quick heating, consistent with adequate soaking, is desirable, since high and prolonged temperatures promote grain growth, without materially affecting any improper carbide distribution persisting to this point. A difference of 5 deg. in the maximum will increase the grain size 15 diameters (Figs. 2 and 3), while 10 deg. to 1310 will liquefy the carbide eutectics. At 1350 deg. the specimen is completely "crozzled." (Fig. 4.) Tool failures may be due to persistent dendritic structure inherited from too hot casting, rare segregations of slag or manganese sulphide, forging cracks, but most often carbide segregations forming banded laminations or grain envelopes.

A study of the microscopic and mechanical properties of several tool steels was presented by Dean J. O. Arnold, and Fred Ibbotson, of the University of Sheffield. Previous researches on plain carbon steels with the addition of a single alloying element has already distinguished the various carbides of chromium, vanadium, tungsten and molybdenum. In the complex mixtures used in these experiments, the same methods were used, namely, electrolysis of the tool steel in HCl (sq.gr. 1.02). The residue of carbides was then analyzed, whence formulæ could be ascribed.

It appears that the relative affinity of carbon for the alloying elements is V, Mo, W, Cr, and lastly Fe. Consequently, with the modest amount of carbon present (0.65 per cent) Fe_3C may be entirely absent in high W-V steels, the hard Cr_3C_2 also giving way to Cr_4C. Microscopically, all the steels in annealed condition are similar, showing a pale background of an intermetallic solution overlaid by dark troostitic and paler sorbitic varieties of a pearlite of unknown composition, the whole being overlaid by nodules (sometimes streaks) of a brilliant white metaral; doubtless a mixture of segregated carbides. When quenched from 1300 deg. C., the Mo-V steel shows well-marked allotriomorphic crystals of a mixed hardenite, which, here and there, are partially surrounded by a unique dark-etching pearlitic constituent, possibly a troostitic vanadium pearlite which does not transform into its hardenite until 1400 deg. A molybdenum steel with no vanadium does not show these areas. Other steels showed allotriomorphic crystals of hardenite of varying sizes, surrounded with thin-cell walls with fairly thick and very broken cell walls of cementite more or less segregated into nodules (sometimes in the crystals themselves).

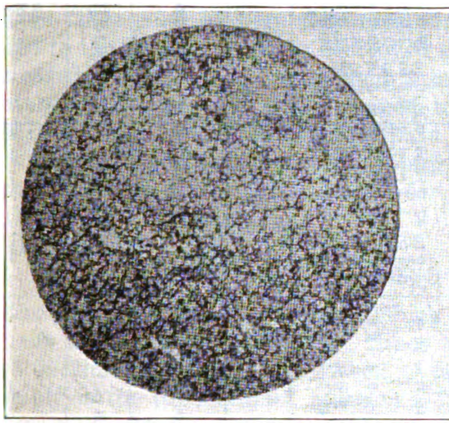


FIG. 2. IDEAL HARDENED CONDITION. TEMPERATURE 1300 DEG. C. X 200, REDUCED ONE-THIRD

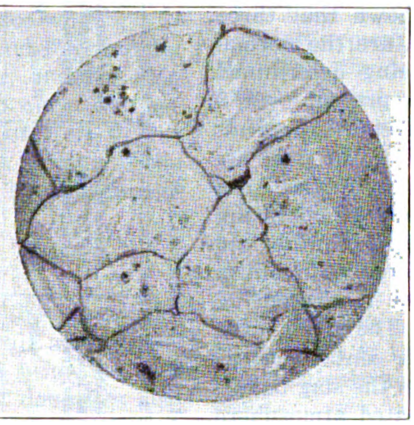


FIG. 3. OVERHEATED IN HARDENING. TEMPERATURE 1305 DEG. C. X 200, REDUCED ONE-THIRD

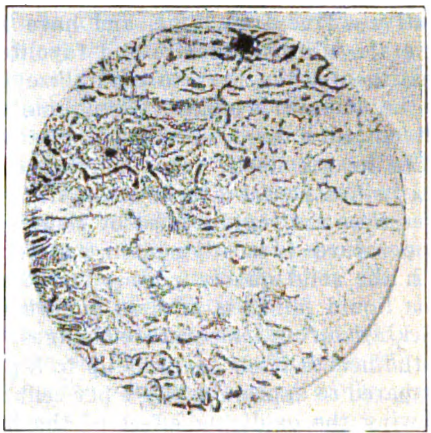


FIG. 4. STEEL HARDENED AT 1350 DEG. C. X 200, REDUCED ONE-THIRD

Chemically the steels were designed to have constant carbon 0.65 per cent, chromium 2.85, silicon 0.4, manganese 0.2, phosphorus 0.015, sulphur 0.06. Vanadium when present was 1.25 per cent, molybdenum either 2 or 6 per cent and tungsten either 12 or 16 per cent. Efficiency tests were made by speeding up a lathe tool until it broke, and measuring the amount of steel removed, with the results shown in the accompanying table.

From the results molybdenum appears to be an acceptable substitute for tungsten at the ratio of about 1 molybdenum to 2.7 tungsten.

STUDY OF THE OPEN-HEARTH PROCESS

Mr. B. Yaneske, of Vickers, Ltd., Sheffield, described in detail a typical melt which he had found best suited, in "Deoxidation, and the Influences of Lime on Equilibrium in the Acid Open-Hearth Furnaces." The nub of his process was to use extreme heat, and to control the silicon (and therefore oxygen) content of the bath as it approached the desired chemical content, by the careful addition of lime. For instance, he melts very hot to attain a very acid slag, since the acidity in equilibrium increases with temperature. When clear melted and very hot the slag will contain about 48 per cent SiO_2, 33 per cent FeO and 16 per cent MnO, the latter variable as to the nature of the pig melted. At this point ore may be added to maintain basicity, complete the elimination of silicon and to speed the "boil." As the heat progresses the slag gets lighter in color and more viscous, until finally SiO_2 becomes supersaturated and it is reduced by the metallic iron, this state of affairs evidencing itself by blowholes on the under surface of metal samples. Then limestone is added sparingly, with the ore, the former to satisfy the SiO_2 and the latter to continue to lower the carbon content of the bath. This method, by the way, is far better than to liquefy the slag by lowering the flame or by chilling with scrap, either of which increases the FeO in the slag by oxidizing metal. At a continuously high temperature, therefore, the decarbonization proceeds, a proper slag being about SiO_2, 58 per cent; FeO, 21 per cent; CaO, 5 per cent; MnO, 12 per cent, and appearing light green in a quenched sample, the metal being watched for bubbles, meanwhile, and fresh additions of lime made as they appear.

Steel No.	Efficiency Position	Type	No. of Tests	Lb. of Steel Removed
1574	1	V-Mo	Six	111.90
1578	2	V-W	Six	109.80
1576	3	V-W-Mo	Six	96.10
1577	4	W-Mo	Six	72.00
1579	5	W	Six	66.60
1575	6	Mo	Five	47.00

As the carbon content approaches that desired in the finished metal, lime additions are made with caution, and only as indicated by the appearance of blowholes from the reaction

$$SiO_2 + Fe = FeSi + O_2$$

Too much lime displaces FeO from the slag, which in turn lowers unduly the carbon in the melt. After sufficient "stewing," metal spoon-samples will appear perfectly sound, with rippled upper surface due to the high-surface tension of pure metals. It is very hot and may readily be cast, and requires few additions for deoxidizers, with the attendant expense and resulting undesirable solid non-metallic inclusions in the steel. Undue loss of additions and a resulting certainty of final analysis are added advantages.

Contained in the paper are descriptions of the appearance of the metal and slag buttons for other conditions than the optimum, together with a discussion of proper methods to recover equilibrium in the bath

A study of acid open-hearth slags and hearths and their influence on steel-making was presented by J. H. Whitely and A. F. Hallimond of the chemical laboratories, South Durham Steel & Iron Co., in "The Acid Hearth and Slag." Their studies were confined to large slag balls principally of the system $FeO \cdot MnO \cdot SiO_2$, relatively free from lime, and have shown that three minerals, silica, rhodonite and fayolite, are the normal constituents, the first to crystallize being determined by the amount present. When lime is present over 8 per cent, an unknown needle-like metasilicate is present.

The hearth itself, even though made up of pure selected silica, contains large quantities of impurities. Its interstices are rapidly filled by slag, which at operating temperatures is mostly molten, and being in equilibrium with the solid quartz grains, is saturated with silica. This liquid filling is of first importance in preventing cracking during temperature changes. The upper layer of the hearth itself contains up to 8 per cent Fe_2O_3 (as compared to approximately 1 per cent in the slag balls), showing the oxidizing effect of the heated atmosphere when exposed between melts. Fortunately the depression in freezing point of silica (or perhaps its decrease in viscosity) by impurities is exceptionally small, which is responsible for the stability of the banks at temperatures at or above its melting point. Pure silica is not desired for fettling, for a minimum of clay, etc., is necessary to "stick" the grains together, without causing the banks to "soften"; on the other hand, inversion of quartz to tridymite is accelerated by impurities, which transformation is accompanied by flowing and crystal growth, all elements of instability. Patching on the bottom also requires a granular material which will absorb residual metal and slag and knit into the foundation in one continuous mass.

In manipulation of acid melts, slag composition is regulated by the addition of ore, which regulates the purification and also maintains the slag at the proper fluidity without excessive cutting of the banks. Calculations of the amount of oxygen required for elimination of impurities, as compared with that furnished by ore, show that if silicon and manganese are taken into the slag by iron or calcium oxides, at least half of the carbon was eliminated by gas oxidation and the remainder of the carbon by ore addition. Large quantities of ore added to a slag will not appreciably increase its ferric iron content; evidently reduction of Fe_2O_3 to FeO is very rapid. It is known that Fe_2O_3 dissociates under atmospheric pressure at 1350 deg.; furthermore, in the system $SiO_2 \cdot Fe_2O_3 \cdot FeO$ a maximum of 4 per cent Fe_2O_3 is probably the limit at furnace temperatures. As a matter of fact, slags have ordinarily much less—seldom exceeding 0.4 per cent Fe_2O_3—the reduction from 4.0 to

TABLE I.—NORMAL STEELWORKS SLAGS

Process	Acid Bessemer	Acid Open-hearth	Acid Open-hearth	Acid Mixer	Basic Mixer	Basic Open-hearth	Basic Open-hearth	Basic Open-hearth	Basic Bessemer
Pig-iron (See Table II)	Hematite	Hematite	Hematite	Any Iron	Any Iron	Hematite	Common forge	"Thomas"	"Thomas"
Additions	Nil	Oxides, lime	Oxides only	Oxides, lime	Oxides, lime	Oxides, lime	Oxides, lime	Oxides, lime	Lime
Normal variations	Range Mean	Range Mean	Range Mean	Range Mean	Range Mean	Range Mean	Range Mean	Range Mean	Range Mean
SiO_2	62.0 to 68.0 = 65 0	57.0 to 63.0 = 60.0	48.0 to 52.0 = 50.0	38.0 to 46.0 = 50.0	36.0 to 42.0 = 39.0	25.0 to 29.0 = 27.0	14.0 to 22.0 = 18.0	10.0 to 14 0 = 12.0	6.0 to 10.0 = 8.0
P_2O_5	....	....	....	....	0.5 to 1.5 = 1.0	0.0 to 2.0 = 1.0	7.0 to 13.0 = 10.0	14.0 to 18.0 = 16.0	18.0 to 22.0 = 20.0
Al_2O_3	4.0 to 6.0 = 5.0	12 0 to 18.0 = 15.0	5.0 to 9.0 = 7.0	9.0 to 15.0 = 12.0	0.5 to 1.5 = 1.0	1.0 to 3.0 = 2.0	1.0 to 3.0 = 2.0	1.0 to 3 0 = 2.0	....
CaO					40.0 to 48.0 = 44.0	46.0 to 50.0 = 48.0	46.0 to 50.0 = 48.0	46.0 to 50.0 = 48.0	48.0 to 52.0 = 50.0
MgO					5.0 to 7.0 = 6.0	4.0 to 6.0 = 5.0	4.0 to 6.0 = 5.0	4.0 to 6.0 = 5.0	4.0 to 6.0 = 5 0
MnO	8.0 to 12.0 = 10.0	5.0 to 15.0 = 10.0	5.0 to 15.0 = 10.0	4.0 to 8.0 = 6.0	4.0 to 6.0 = 5.0	4.0 to 12.0 = 8.0	4.0 to 12.0 = 8.0	4.0 to 12.0 = 8.0	4.0 to 12.0 = 8.0
FeO	18.0 to 22.0 = 20.0	12.0 to 18.0 = 15.0	28.0 to 38.0 = 33.0	35.0 to 45.0 = 40.0	3.0 to 5.0 = 4.0	5.0 to 14.0 = 9.0	5.0 to 14.0 = 9.0	5.0 to 14.0 = 9.0	5.0 to 14.0 = 9.0
Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total acids	65.0 = 1.86 to 1.00	60.0 = 1.50 to 1.00	50.0 = 1.00 to 1.00	42.0 = 0.725 to 1.00	40.0 = 0.666 to 1 00	30.0 = 0.43 to 1.00	30.0 = 0.43 to 1.00	30.0 = 0.43 to 1.00	28.0 = 0.39 to 1.00
Total bases	35.0	40.0	50.0	58.0	60.0	70.0	70.0	70.0	72.0
Approximate finishing temperatures °C.	1500 to 1600	1400 to 1500	1400 to 1500	1200 to 1300	1200 to 1300	1400 to 1500	1400 to 1500	1400 to 1500	1500 to 1600
Mechanical losses of non-recovered metal, per cent of charged weight....	Direct metal 6 Duplex 4	2 (cold pig	and scrap)		2	4 (direct 3 (cold pig	metal) and scrap)		Direct metal 6 Duplex 4

TABLE II.

	C	Si	P	Mn	
1. Hematite—mixed Nos.	3.80	2.50	0.06	1.00	Natural hematite iron
2. Hematite—special....	3.20	1.00	0.06	0.80	Special hematite (American "Bessemer")
3. Common forge........	3.50	1.80	1.50	0.60	Natural iron (Cleveland, Northants)
4. Common basic........	3.20	1.00	1.25	1.20	Low-silicon iron with proportion of foreign ores
5. "Thomas" special.....	3.20	0.50	0.50	2.25	Continental — high phosphorus and manganese

0.4 per cent is evidence that Fe_2O_3 is extremely active as an oxidizing agent, even producing much free oxygen during heavy oreing. It is also continuously formed on the slag surface by furnace gases, as shown by the gradual thickening of the slag during the quiet finishing stage, when carbon in the bath is removed slowly with concurrent increase of Fe_2O_3 from say 0.2 to 2.0 per cent in the slag.

Several decarburizing reactions may be written. Consider

$$FeO + C = CO + Fe$$

This takes place at very slow rate, since when ore is added to the furnace Fe_2O_3 is destroyed and FeO rapidly increased. Again, 0.86 metal held 2 hr. under a slag containing 24 per cent FeO dropped to only 0.38 per cent C, with a corresponding decrease of FeO to but 20.8 per cent; calculation showing a large portion of the decarburization to be unaccounted for by the change $FeO \longrightarrow Fe$

The reaction

$$Fe_2O_3 + Fe = 3\ FeO$$

is the only plausible reaction in which the percentage of iron in a slag can be raised. Since this actually occurs in the finishing stages, when C is below 0.15, it possibly is the predominant reaction. It doubtless also occurs during the boil, counteracting somewhat the effect of the then more prominent reaction

$$Fe_2O_3 + 3\ C = 3\ CO + 2\ Fe$$

or possibly $Fe_2O_3 + C = CO + 2\ FeO$

The authors conclude that the rapid reduction in carbon is due to gas reduction either direct or by Fe_2O_3 acting as a carrier; the latter being formed on the surface layers of the slag, and reacting with the slag-iron interface, most particularly of metal shot dancing in the slag whose quantity equals ½ ton in a 100-ton bath. Therefore the use of a rich gas with as much air as the furnace can carry will afford best conditions for carbon removal—that is, rapid thickening of slag after more frequent ore additions. Consideration of the rate at which the bath is decarbonized after the boil (entirely by Fe_2O_3), and during the boil, also leads to the assumption that perhaps ½ of the decarbonization by gas-reduction is due to contact between gas and metal shot during the boiling period.

MODERN STEEL METALLURGY

Mr. C. H. F. Bagley, technical supervisor for the South Durham Steel Co., presented a discussion of "Modern Steel Metallurgy," a calculation and comparison of processes, particularly as refers to the slags formed. In brief, it is a treatise on the metallurgical calculations of steel-furnace slags, so collated that given unit prices for different qualities of the necessary constituents, the the best combination for any modern process may be actually determined with confidence, or, on the other hand, the best process for a given set of conditions may be found when planning a new works. The author pays particular attention to the slag produced, laying emphasis upon the fact that steel making also involves slag making, and, other things being equal, it is true that any factor which lessens the quantity of slag made will at the same time increase the output of iron and lower its cost.

TABLE III.

Duplex Hot Metal Processes (Common Forge)	Preliminary			Basic Open-Hearth Finishing Furnace			Combined		
	Mixer	Acid Bess.	Basic Bess.	Mixer	Acid Bess.	Basic Bess.	Mixer	Acid Bess.	Basic Bess.
Lime........	4.4	1.21	4.5	8.45	7.5	7.3	13.0	8.0	11.2
Oxides......	11.6	....	....	19.1	13.6	14.45	31.1	12.2	13.2
Yield........	102.2	89.8	91.4	102.8	101.3	101.3	105.1	91.0	92.8
Slag make....	9.4	8.10	9.6	16.9	15.0	14.6	17.3	13.5	13.4
Slag P_2O_5 per cent...	1.2	....	1.1	19.7	22.8	22.7	19.7	22.8	22.7

There is nothing particularly novel in the method of calculations. In general, given the analysis of metal charged and the amount of metal tapped, the amount of oxidation can easily be figured. Oxygen comes either from blast or ore; in the latter case, additional slag-forming impurities are added. These, with the impurities from the bath, will form a slag which in a given process varies within rather narrow limits at the end of the operation (whatever it may have been meanwhile) in order that it may be thin enough to pour, quiet, stable and non-corrosive. From such known composition, and a little auxiliary data as to mechanical losses, a metallic and non-metallic balance sheet can easily be obtained, giving the yield in metal per unit charged, the slag make and the weight of all additions.

Principal data are assembled in Tables I and II. As an instance of the results Table III summarizes the author's calculations on the various styles of duplex processes.

Lignite Utilization Board of Canada

Although Canada possesses large coal deposits, it has been necessary to import about 500,000 tons of anthracite from Pennsylvania at a cost of about $5,000,000 per annum. The lignite deposits underlying various districts of the Provinces of Saskatchewan and Alberta are unsuited in the raw state to household use. By carbonizing, however, a coke is obtained which briquettes readily; two tons of the inferior fuel giving one ton of briquettes which approximate anthracite in heating value.

The Lignite Utilization Board was created to investigate machines and processes for carbonizing, briquetting, etc., and to construct a plant of commercial size for the production of domestic fuel. Consideration will also be given to the utilization of by-products and of powdered fuel for commercial power production.

Ramsay Memorial Fund

The committee for the *Ramsay Memorial Fund* for the United States reports the receipt of contributions totaling $4700, which, after deduction of current expenses for printing, postage, etc., will leave about £900 for transmission to the Fund headquarters in London. The committee had hoped to be able to transmit at least £1500 at this time, and will therefore welcome further contributions. Checks should be sent to the chairman, Dr. Charles Baskerville, 140th St. and Convent Ave., New York, or to the treasurer, Mr. William J. Matheson, 21 Burling Slip, New York.

Synopsis of Recent Chemical and Metallurgical Literature

Copper in Slags—A very important contribution to our knowledge as to the exact condition in which copper is held in furnace slags appeared in *Engineering and Mining Journal* for May 10, 1919, Volume 107, page 815, from the pens of C. G. MAIER and G. D. VAN ARSDALE. Their investigations were confined exclusively to Phelps-Dodge slag when making a 30 to 40 per cent matte by smelting raw or roasted sulphides. Microscopically, such matte shows FeS islands in Cu_2S, ground mass, as in the globule of Fig. 6. Silver-nitrate is a good etching agent, deeply corroding the Cu_2S, which fact is utilized in determining whether any copper sulphide is present as a true solution in the slag. Under a microscope this reagent showed no effect on slag, while it actually dissolved more than 98 per cent of the copper from mattes and white metal. The equation is probably

$$Cu_2S + 4AgNO_3 = 2Cu(NO_3)_2 + 2Ag + Ag_2S$$

Analyses of several blast-furnace and reverberatory slags showed an average residue of 0.7 per cent copper insoluble in $AgNO_3$, with an average deviation of only 0.11, which figure (0.7 per cent) possibly represents the maximum solubility of some copper compound in such slags as 36 per cent SiO_2, 10 per cent Al_2O_3, 34 to 42 per cent FeO, 4 to 18 per cent CaO + MgO.

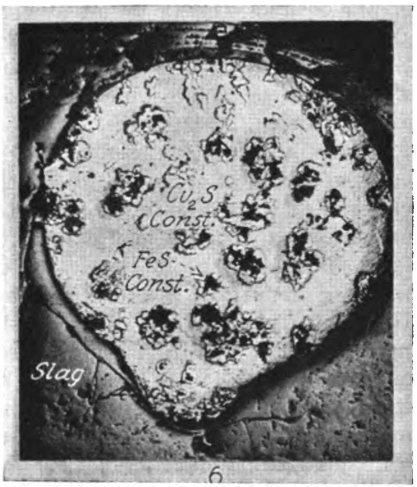


FIG. 6. BLAST-FURNACE SLAG. CHILLED UNETCHED INCLUSION IS UNALTERED MATTE. × 35

Table I shows various possible forms whereby copper may be held in slags.

Since no oxidized copper minerals were found in crystallized samples, and also since the copper dissolved in slags appeared to be a constant quantity, it is probable that no copper is held in solution as oxide. When remelting slag with various proportions of cupriferous pyrite as plotted in Fig. 3, the per cent of copper in the resulting slag was quickly reduced to the amount originally held in solution. It is therefore probable that copper is not dissolved as metal, because the addition of pyrite already saturated with Cu_2S does not change the total in solution in the slag as would then be expected by the sulphidizing action of the pyrite. The addition of copper-free pyrite shown in the middle curve

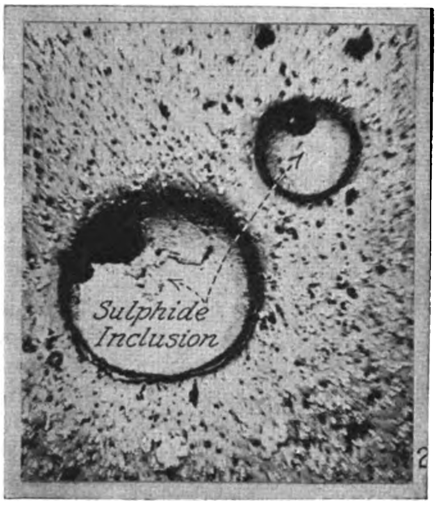


FIG. 2. CONVERTER SLAG, UNETCHED. FLOTATIVE EFFECT OF BUBBLES INDICATED BY CO-PLANAR OCCURRENCE. × 150

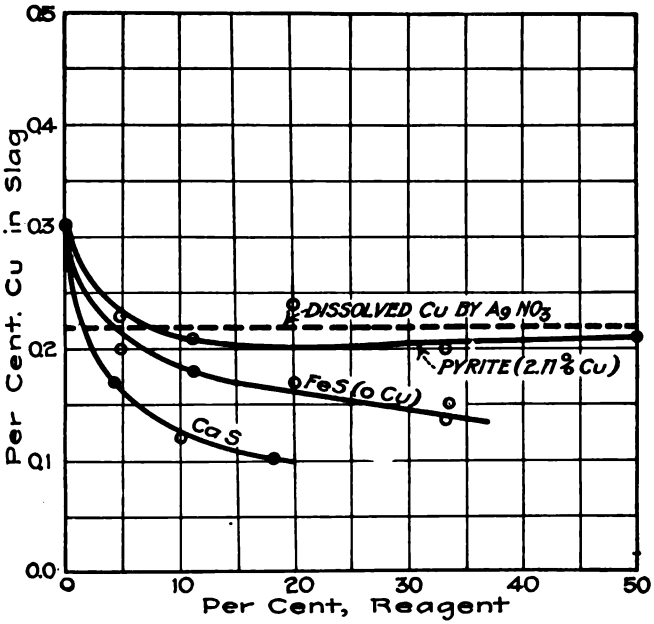


FIG. 3. EFFECT OF FUSING REVERBERATORY SLAG WITH SULPHIDES

TABLE I. COPPER IN SLAGS

Microscopically	Visible				Invisible						
Physical Forms	Group 1 Macro } Micro } scopic particles				Group 2 { Ultramicroscopic particles { Colloidal solution			Group 3 True Solutions			
Possible Forms	(Matte)	Cu_2S	Cu	Dissolved in FeS	(a) Matte	Cu_2S	Cu Oxides and Silicates	Cu_2S	Cu and Oxides	Cu_2O } CuO } (SiO_2)	Cu_2O } CuO } { Fe_2O_3 { Al_2O_3
Actual occurrence as observed or concluded........................	Occasional	Usual	Seldom, oxides or silicates not observed	If so, very small in amount	Very improbable	Probable	Improbable	Probable	Improbable	Improbable	Improbable
Indicated lines for experiment........	Settling by control: { Temperature { Density { Viscosity Prevention of flotation.				Coagulation and Settling			Salting out: By variation of constitution. By additional agents			

(a) Matte is a variable complex material containing at least two constituents, one of which is readily attacked by Fe_2O_3, and it is not proper to speak of its solubility as such. There must also, therefore, be a limiting size to the matte particles, below which they cannot exist in suspension.

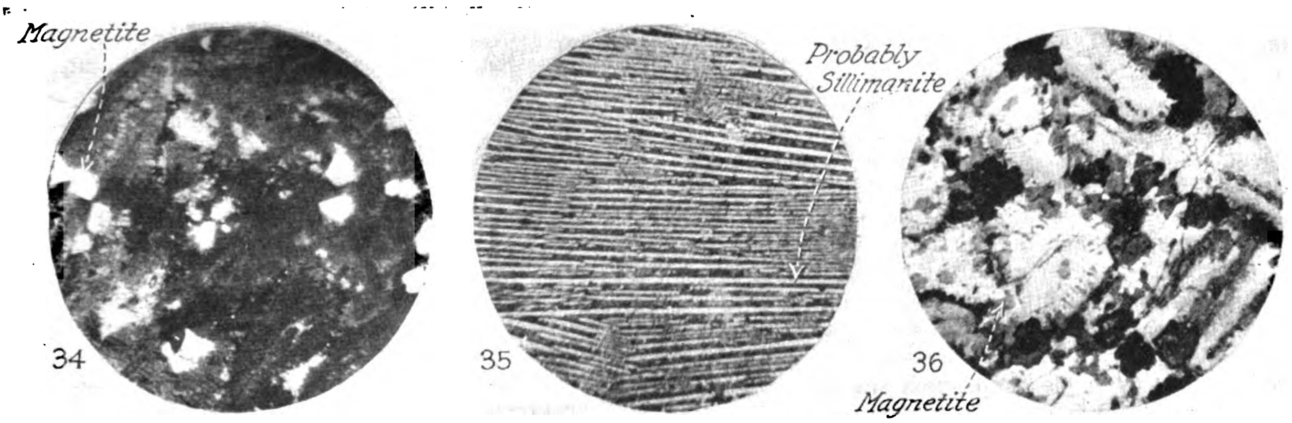


FIG. 34. REVERBERATORY SLAG, ETCHED WITH HF. FUZZY CRYSTALLINE EDGES SHOW SEPARATION OF Fe_2O_3. × 380. FIG. 35. WELL CRYSTALLIZED BLAST-FURNACE SLAG, ETCHED WITH HF COLUMNAR CRYSTALS WITH NO MAGNETITE. FIG. 36. FIRST-SKIM CONVERTER SLAG; HEAT-TINTED

reduces the dissolved copper, now assumed to be copper sulphide because of the distribution effect between slag and sulphide phase, and the idea that the copper is held as Cu_2S is further reinforced since the addition of CaS reduces the total copper because it increases the concentration of a common ion—in this case sulphur. The actual nature of this soluble sulphide is not known, but it very likely contains little FeS, because the latter ordinarily tends to disappear in the microscopic globules observed—in other words the shot of typical matte shown in Fig. 6 is usually replaced by spherical inclusions such as Fig. 7 or 10, where the FeS has largely disappeared, thus leaving particles of Cu_2S containing more or less FeS in solution. Iron sulphide constituent is not commonly observed even in slags from high grade matte.

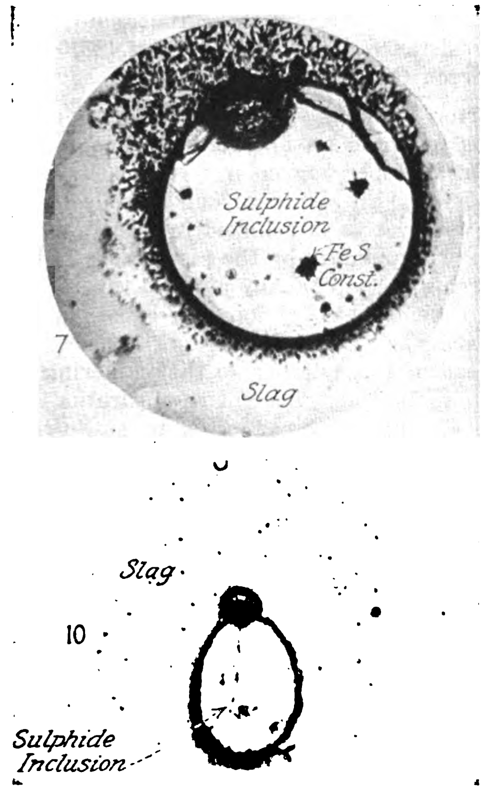


FIG. 7. CHILLED BLAST-FURNACE SLAG; INCLUSION WITH LITTLE FeS. × 35. FIG. 10. CHILLED BLAST-FURNACE SLAG; FeS CONSTITUENT ELIMINATED; WELL DEVELOPED GAS BUBBLES. × 150

Gas bubbles appear to be attached to the inclusions shown in Figs. 7, 10 and 2, and the authors believe that this gas is derived from the disappearing FeS according to the reaction $FeS + 3Fe_2O_3 = SO_2 + 7FeO$. Of course, FeS might settle out physically as shown in Fig. 6, but this is never complete and occurs only at a narrow range of temperatures giving a mushy state. From microscopic evidence, the authors conclude that, since gas bubbles accompany the disappearance of FeS, the gas is probably SO_2. It is logical to assume that Fe_2O_3 is the oxidizing agent since ferrous oxide and dissolved air would produce metallic iron and copper, respectively, neither of which was found. Ferric oxide is present, since it is required to form the magnetite ordinarily present in furnace slag. Magnetite occurs in converter slags in allotriomorphic crystals shown in Fig. 36. Magnetite is also present in reverberatory slags in holomorphic crystals often with fringes of dark colored Fe_2O_3 (Fig. 34), or in dendritic form (Fig. 27). However, magnetite was not found by these authors in their blast-furnace slags, whose structure is represented by Fig. 35.

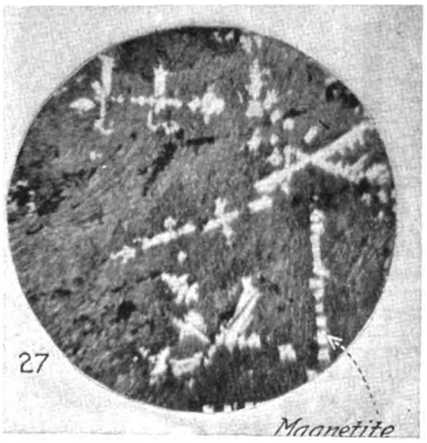
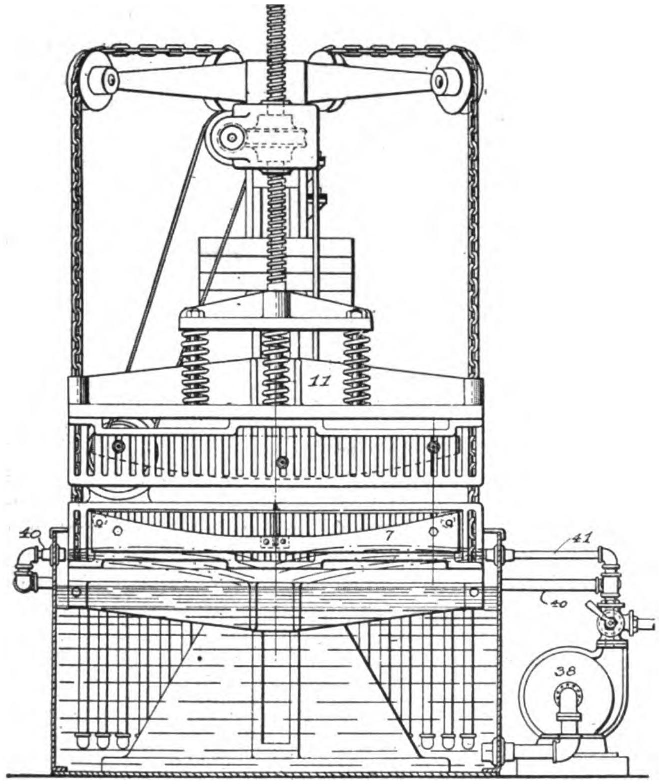


FIG. 27. REVERBERATORY SLAG, ETCHED WITH NaOH. × 150

Apparently, therefore, copper is held in furnace slags to a certain small extent as a true solution of sulphide, while the balance occurs as globules of white metal floated by attached gas bubbles. Continued settling would not appear to reduce the quantity of the latter, which could only be done by changing the composition of the slag so as to practically eliminate the occurrence of ferric oxide. Converter slags may contain as high as 0.5 per cent of copper in true solution, with the balance present as particles of white metal. As the blow continues the soluble copper continually decreases. Here is additional evidence that practically no copper silicates are formed in normal furnace practice.

Recent Chemical and Metallurgical Patents

Automatic Hardener.—T. J. FAY of Brooklyn, N. Y., has patented a special machine, illustrated herewith, designed for the automatic cambering and heat treatment of such parts as spring leaves. A heated plate of spring steel containing about 1 per cent carbon is heated to about 1535 deg. F., and placed on the lower anvil 7. The recessed upper head 11 then descends, shaping the bar to the desired radius. The entire assembly then descends past the oil sprays 40 and 41 into the tank below, which contain an oil layer 12 in. thick, resting upon a body of water. The passage of the oil layer requires 3 sec. when the hot metal is held in the water for 57 seconds. After this time the mechanism is elevated out of the fluid, and the cool, cambered bar removed from the machine. The temperature of the metal and the relative time it is held in oil and water are subject to variation depending upon the kind of metal being treated. The entire equipment is electrically driven and by means of time relays the proper intervals can be absolutely fixed and repeated, so that at the end of the operation the core of the leaf will contain enough residual heat so that it may be properly annealed by blooming. (1,298,682; assigned to Standard Parts Co., Apr. 1, 1919.)



AUTOMATIC HARDENER

Ignition of D. & L. Cake.—C. W. ADAMS of Murray, Utah, notes that many times the usual oil-flame ignition for a Dwight & Lloyd sinter cake is not entirely satisfactory. In some cases such intense ignition fuses a crust on the top of the ore, making the charge semi-impervious to the passage of oxygen. This causes elemental sulphur to distill into the flues, giving rise to the danger of explosive combustion. High loss in lead and silver is also characteristic of such practice. The inventor proposes to ignite the cake by spreading a thin layer of hot calcine on it. One-half inch of a bright red calcine having 12 to 15 per cent sulphur content has been satisfactorily used and has been found to obviate the disadvantages attending high-temperature ignition. For ease it is suggested that the hot calcine be discharged from a roasting furnace placed directly above the sintering machine. (1,299,892; assigned to American Smelting & Refining Co., Apr. 8, 1919.)

Resistors for Electric Furnace.—H. G. WEIDENTHAL of Cleveland, Ohio, suggests a novel arrangement for an electric furnace, whereby gangs of parallel, vertical resistors form the inner lining of the furnace laboratory. These terminate below in a conductor placed below a refractory hearth, which is banked up somewhat above their lower ends, and above are clamped to a conducting bar, in such a way that any damaged individual may be easily removed. Resistor gangs are so arranged as to allow spaces for pouring spout, and charging and inspection doors. For the individual resistors the inventor suggests molded rods of carborundum sand, coated with crystalline corborundum. At least one of each gang must have a small conducting rod in its axis, so as to start the current through the carborundum, which has a high resistance when cold. (1,304,425, assigned to J. H. Herron Co.; May 20, 1919).

Converter Puncher.—CHARLES J. ARCH of Douglas, Ariz., has patented an automatic device for punching tuyeres in a copper converter. It consists of a frame carrying several air cylinders, one lined up for each tuyere, and with valves interlinked in a train so that each tuyere shall be punched by the piston rods in succession upon starting the first. Any plugged tuyere can also be skipped. Removable piston-rod ends are provided against wear, and a circular scraper is placed some distance ahead of the cylinder so that adhering slag may be peeled off the rod. The entire apparatus is counterweighted and normally connected by side arms to the connector shell and it tilts in a circle as the converter moves. Automatic releases are provided, however, so that the puncher is left stationary when the converter passes a limiting position. (1,303,755, May 13, 1919.)

Electrolytic Tungsten.—Present methods of drawing hot tungsten wire through diamond dies lubricated with graphite form an undesirable carbide alloy. F. G. KEYES of Cambridge, Mass., finds that WO_3 will dissolve in boric acid at 1200 to 1400 deg. C., and may then be electrodeposited upon, say, a fine tungsten wire. When the deposit has grown to sufficient size. it will be found somewhat ductile and can be drawn through dies of high-speed steel lubricated with talc (1,293,117; assigned to Cooper Hewitt Electric Co., Feb. 4, 1919.)

Crucibles.—F. J. TONE of Niagara Falls. has discovered that a very excellent crucible for melting metals can be made of 40 per cent graphite ground to 16 mesh, 40 per cent commercial magnesia, sintered in the electric furnace and ground to 40 mesh, and 20 per cent plastic refractory clay. This forms a plastic mass which can be made into crucibles and fired in the ordinary manner, and produces a superior, tough article which resists scaling or slabbing under heat variation in a superior manner. (1,303,993; May 20, 1919.)

Detinning Process.—Walter Zacharias of Pittsburgh, Pa., has discovered that when dry tin scrap is treated with chlorine, the reaction forming SnCl$_4$ starts at local points when the concentration reaches a rather high figure, but rapidly spreads to all parts of the mass by the liberated heat. In order to prevent unduly high temperatures (which form undesirable iron chlorides) and loss in excess chlorine, he proposes to start the reaction when only low concentrations of chlorine are present by the addition of finely powdered metallic tin, which by virtue of its high specific surface will react at low temperatures and concentrations. He also proposes to place a hopper containing powdered tin above a suitable opening in the detinning vessel, so that this reagent can be introduced at will to regulate the temperature within, and to avoid the loss in time, chlorine, iron and tin chloride certain to follow undue irregularities. (1,283,016; Oct. 29, 1918.)

Improvements to Electric Furnaces.—W. E. Moore of Pittsburgh, Pa., patents features designed to improve mechanical operation of electric furnaces. For instance, he recommends an arched bottom plate so that local heating may not destroy the furnace lining by buckling. A tilting arrangement consisting of stationary traction rollers, gear driven, is also suggested. Electrode holders should also be mounted at the side of the furnace and capable of rotation about the axis of their supporting column, so that they may be swung away from the furnace roof when renewing roof or electrode. This arrangement also allows the hoisting chains to be drawn together to a point near the tilting center of the furnace, and thence leading them off to any convenient location for the motors. Electrode holders and arms themselves should preferably be split and hinged somewhat as shown in Fig. 1, to provide for the variation in sizes of carbons. Improved door and spout construction is also described. (1,304,350; May 20, 1919.)

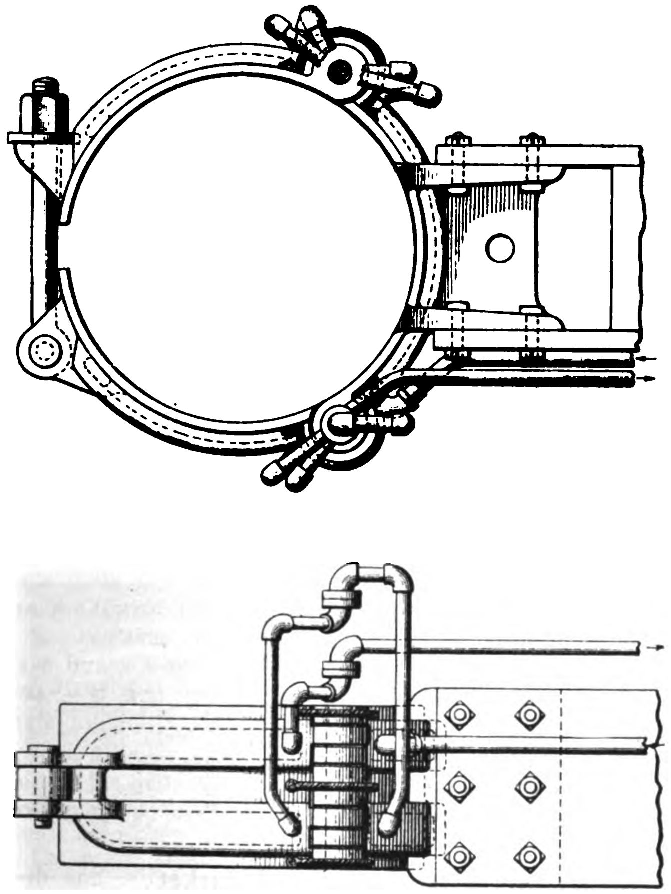


FIG. 1. ELECTRODE HOLDER

Blast-Furnace Uptakes.—Julian Kennedy of Pittsburgh, Pa., patents a blast-furnace top construction shown in Fig 2, involving inclined uptakes (6) discharging through restricted openings (10) into a downcomer branch (8), which latter connects with a similar set on the other side of the skip-bridge (4). This construction is proposed in order that a considerable proportion of the dust taken off by furnace gases or explosions may be arrested and fall back into the furnace proper before passing into the downtake. (1,303,914; May 20, 1919.)

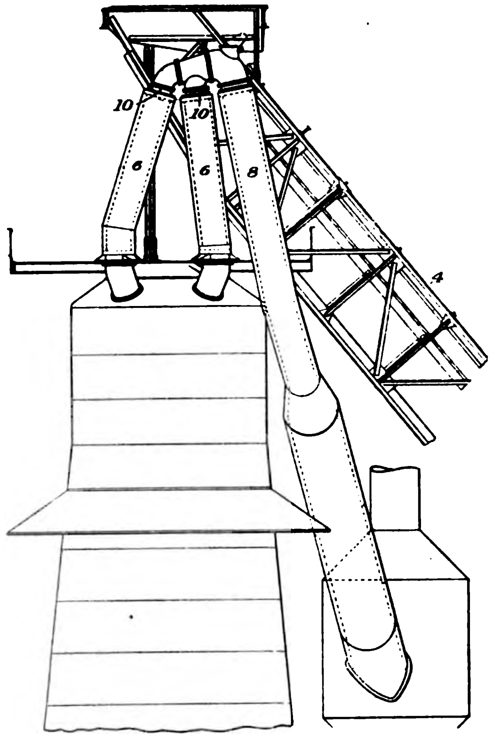


FIG. 2. BLAST-FURNACE TOP

Preparation of Iron Ore.—W. G. Swart of Duluth, Minn., and B. G. Klugh of Anniston, Ala., note that certain fine or clay-bearing iron ores or concentrates, or high-sulphur ores, must be agglomerated before use in blast-furnaces. Commercially such agglomeration is best performed on an intimate mixture of fine ore and solid fuel, with sufficient water to make it plastic. Mixing of such wet, sticky masses is extremely difficult and expensive, and the inventors propose to take unwatered concentrates (or make up a thin pulp of the iron-bearing material), add dry pulverized coal or even wet peat, agitate thoroughly, and then filter the now well-mixed mass on a continuous filter so operated that the resulting cake shall have the proper proportion of moisture for sintering. (1,303,411, May 13, 1919.)

Lactic Acid.—By digesting sawdust with a solution of lactic acid, George A. Richter of Berlin, N. H., obtains a mixture containing reducing sugars. After filtering, the solution is treated with an excess of calcium carbonate and fermented by lactic acid bacteria. The excess CaCO$_3$ serves to neutralize the lactic acid as rapidly as it is formed during fermentation. Sufficient sulphuric acid is added to precipitate all the calcium as sulphate, which is filtered off, leaving a solution of lactic acid. (1,305,623; assigned to the Brown Company; June 3, 1919.)

Personal

The Salt Lake office of CHEMICAL & METALLURGICAL ENGINEERING has been closed and transferred to Rialto Building, San Francisco, Cal. Mr. Ernest E. Thum, formerly Western Editor, will be transferred to New York City as associate editor and Mr. L. W. Chapman, formerly with the Anaconda and duPont organizations, will go to San Francisco as Western editor.

DR. RAYMOND F. BACON, Director of the Mellon Institute of Industrial Research, received the honorary degree of Doctor of Science, on the occasion of the annual commencement of De Pauw University, Greencastle, Indiana, on June

DR. H. K. BENSON has received his discharge as a captain in the research section of the nitrate division of the Army Ordnance and has returned to the University of Washington, Seattle, to resume his work as professor of chemical engineering and administrative head of the Department of Chemistry.

MR. FRANCIS S. BOSQUI will shortly open his office as metallurgical engineer at 90 West Street, New York City.

MAJOR ARTHUR S. DWIGHT, 11th Engineers, has recently returned to civil life after two years service in France with the A. E. F. On June 26 he addressed the New York Section of the A. I. M. E. on his war experiences.

MR. ELLWOOD HENDRICK, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING, expects to sail for Venezuela, Wednesday, July 2.

COL. G. A. BURRELL has received the Distinguished Service Medal for his work as chief of the research Division, Chemical Warfare Service, during the war.

DR. VANNOY H. MANNING, director of the United States Bureau of Mines, on the occasion of the annual commencement of the University of Pittsburgh on June 13, received the honorary degree of Doctor of Engineering, in recognition of his noteworthy accomplishments in the investigation of problems of mineral technology. The university also conferred the honorary degree of Doctor of Chemistry upon **DR. WILLIS R. WHITNEY**, director of the Research Laboratory of the General Electric Co., Schenectady, New York, because of the valuable service which he rendered to the Government as a member of the Naval Consulting Board. These honorary degrees were given upon the recommendation of the Mellon Institute of Industrial Research, an integral part of the University of Pittsburgh.

PROFESSORS W. A. PATRICK and **M. E. REID** of the chemical department of the Johns Hopkins University will act as consulting chemists for the du Pont organization during part of the vacation period.

DR. J. W. RICHARDS, professor of metallurgy in Lehigh University and secretary of the American Electrochemical Society, leaves New York July 3 for Norway. After visiting some electrochemical plants in Norway and Sweden, and his son in Copenhagen, Dr. Richards will return about the middle of September.

MR. E. H. ROBIE, recently assistant metallurgist for the Canadian Copper Co., Copper Cliff, Canada, has joined the editorial staff of *Engineering and Mining Journal.*

DR. JULIUS STIEGLITZ has been appointed chairman of the advisory committee on synthetic drugs to the Chemical Foundation, Inc., New York.

MESSRS. THORNE L. WHEELER and **JOHN C. WOODRUFF** have formed a partnership for the general practice of chemical engineering under the firm name of Wheeler & Woodruff, with offices at 280 Madison Ave., New York.

MR. EDWARD S. WIARD has resigned as consulting engineer for the Colorado Central Mines Co. and the Anondaga Mines Co. and will resume regular practice at 409 Boston Bldg., Denver, Colo.

MR. HORACE V. WINCHELL, president of the American Institute of Mining and Metallurgical Engineers, recently addressed the New York Section on the new developments at the Eastern end of the Mesabi Range in Minnesota.

Book Reviews

BOILER CHEMISTRY AND FEED WATER SUPPLIES. By *J. H. Paul.* 242 pages, illustrated. New York: Longmans, Green and Co.

The author has included a great amount of original data taken from his own experience. The book is written with the point of view of the usual technical training of the average power engineer in mind. Boiler chemistry is mainly concerned with the innumerable reactions that take place when natural waters are heated to around 400 deg. F. under a pressure of fifteen to twenty atmospheres. The chapter on water softening processes is too limited in scope. The book will serve a long neglected field and should be read by all engineers concerned with steam engineering.

WALLACE SAVAGE.

Current Market Reports

The Non-Ferrous Metal Market

Tuesday, June 24.—The prospects of the signing of the Peace Terms as well as the summer impetus toward increased construction work have greatly strengthened the metal market. Prices that had declined are now rising.

Aluminum:—No variation from the 33c. per lb. price on 98-99 per cent ingots is reported. Scrap sales are equally stable: Cast, 20-23c.; sheet, 20-23c., and clippings, 22½-26c. Sheets, 18 gage and heavier, 42c. Powder, $0.70-1.40 lb.

Antimony:—There is a slight shortage in antimony supplies, wholesale spot bringing 8⅝c. and future 8-8½c. lb. Job lots, 8⅝c. lb.

Copper:—The copper market is showing considerable strength with 18c. lb. for spot and 18½c. for August futures. Predictions of 20c. copper are being made.

Copper sheets, hot-rolled	lb.	$0.25½—	.....
Copper sheets, cold rolled	lb.	.26½—	.....
Copper bottoms	lb.	.25 —	.....
Copper rods	lb.	.19 —	.....
Copper wire	lb.	.18½ —	$0.19
High brass wire and sheets	lb.	.20½—	.....
High brass rods	lb.	.19½—	.....
Low brass wire and sheets	lb.	.20½—	.....
Low brass rods	lb.	.22½—	.....
Brased brass tubing	lb.	.31½—	.....
Brased bronze tubing	lb.	.36 —	.....
Seamless copper tubing	lb.	.30 —	.....
Seamless bronze tubing	lb.	.36 —	.....
Seamless brass tubing	lb.	.29 —	.....
Bronze (gold) powder	lb.	1.00 —	.....

Lead:—Lead has advanced 0.15c. and spot New York is 5.4s. and St. Louis 5.15c. Sheet lead, 8.5c. lb.

Tin:—Spot tin is quoted at 71c. lb. and August futures, 52c. Trading in tin will start in the New York Metal Exchange on July 7.

Zinc:—July spelter is bringing 7.15c. in New York and 7c. in E. St. Louis.

OTHER METALS

Bismuth	lb.	$3.20 —	$3.65
Cadmium	lb.	1.40 —	.....
Cobalt	lb.	2.50 —	3.50
Magnesium	lb.	1.75 —	2.10
Mercury	75 lb.	95.00 —	......
Nickel	lb.	.40 —	.45
Iridium	oz.	175.00 —	......
Palladium	oz.	115.00 —	120.00
Platinum	oz.	105.00 —	....
Silver	oz.	1.11½—	......

The Iron and Steel Market

The key to the steel market's future is the relation between the buying of steel for ordinary everyday consumption and the buying of steel for construction purposes or permanent investment. Such claims as have been made that the outlook is unfavorable have been based on a view that buying of steel for permanent or prolonged use, in other words for investment, is abnormally small, but such an argument defeats its own end, for it that were true the buying that has been in progress has been purely for current consumption, and that buying has lately represented more than 60 per cent. of the productive capacity.

The accepted estimate, however, is that normally more than 50 per cent. of the steel passes into permanent use. One of two things is the case. Either the current needs of the country have tremendously increased, so as to represent more than 60 per cent. of the capacity. or there really has been at least a moderate amount of buying of steel for permanent use or investment. In either case the steel outlook is obviously favorable, for buying for current use would naturally increase as unsettlement due to the war's ending passes, and buying for investment purposes is certain to come, or to increase. Investments must be made, for large quantities of capital have accumulated, awaiting investment, and steel in the form in which it leaves the mills is cheap, since finished steel products are now about 80 per cent. above their ten-year pre-war average, whereas the Dun and Bradstreet index numbers, covering commodities in general, stand at double their ten-year pre-war averages. Thus commodities in general will buy more steel than formerly. Steel has been affected less by the expansion, commonly though unfortunately called "inflation," than have commodities in general. Hence, when investments must be made, investment in steel is particularly attractive.

Effects of Peace Treaty

While a great many views that were entertained just before and after the signing of the armistice have had to be modified, there is among others one view then entertained that has molded men's conduct, whereby light upon the future is thrown. That view was that investment would not proceed freely until the peace treaty should be signed. There can be no doubt that investments, particularly in works of construction, have been held back awaiting the formal establishment of peace by the signing of the treaty. The view that there would be an immediate or at least a prompt "deflation" in prices has been discarded, but the holding of the view for so long operated to delay the conversion of liquid capital into works of construction for investment purposes, involving the purchase of commodities and employment of labor.

It is true that some investors might be expected to anticipate the arrival of the formal peace, but the fact that as the months after the armistice passed, peace, with stable governments in Europe, seemed to recede instead of approach, had a tendency to discourage investors. Furthermore, many investments or undertakings rest upon the vote of boards of directors, many of the members being indisposed to anticipate, but to follow one plain policy, of refusing to endorse new ventures until peace should be sealed by the signing of the formal treaty by responsible and stable governments. That event having occurred, a great many new ventures will undoubtedly be launched quickly.

New Construction

By no means, however, has the inception of new construction awaited this time. By far the most accurate index to new construction such as particularly interests the steel trade is the monthly compilation of the Bridge Builders' and Structural Society of the amount of fabricated steel work let to the fabricating shops. In terms of monthly fabricating capacity the bookings have been as follows: January, 12 per cent; February, 12½ per cent; March, 17½ per cent; April, 24½ per cent; May, 49 per cent. When the volume of this business doubled from April to May it seems altogether reasonable to conclude that the signing of the peace treaty will result in a very large further increase.

There has been a curious reversal in the outlook as to the time when various new enterprises would be undertaken. Assuming, as practically everyone did, that a large quantity of construction work had piled up, the reasonable view not long ago, when it was expected that construction costs would gradually decline, was that the work undertaken first would be the more pressing work, that in which first cost was the less important consideration and time the more important, so that as time passed one class of work after another would be undertaken. Now, however, when the common view is that construction costs are approximately as low as they are likely to be for several years, with possibilities that they will increase, the majority of investors are likely to be disposed to take hold at once. Their activities will be limited not so much by fear that the passage of time would write a depreciation on investments through construction costs declining as by inability to secure steel deliveries or labor with which to put the steel into employment. A rapid rather than a slow recovery in steel is therefore to be expected.

Production

The low point in steel production fell at some time in May, probably about in the middle of the month, the rate, measured in steel ingot output, being down nearly if not quite to 50 per cent of capacity, the average production for the month having been 54 per cent. The computation is based upon the fact that 30 companies, which in 1918 made 84.03 per cent of the country's total steel ingots, reported 1,929,024 tons as their output in May, while the capacity of the country may be taken at 49,000,000 tons a year. The average 54 per cent rate for May compares with 65 per cent for April, 77 per cent for March, 85 per cent for Feburary and 87 per cent for January. Since this low point of about 50 per cent. there has been a steady increase, consequent upon the increase in the buying of steel that began about the second week in May, and June production may be taken as having been at about 60 per cent of capacity on an average. Apart from such inroads upon output as may be made by midsummer weather, the recent 50 per cent rate will probably stand as the low record for several years.

Prices

The test of the stability of the "regular" or "recognized" steel prices, those that became effective March 21, is the cutting that has occurred during the past three months. When with light mill operation there is no price cutting the evidence is clear that mills are afraid to cut, lest the bottom drop out of the market. Such a fear actuated the producers from the time of the armistice until April. Lately there has been price cutting in nearly all finished steel products, not by the majority of mills, but by a minority. The majority have been content to let the price cutters take such business as could be secured by that means, finding that their relations with their customers, and the service they furnish year after year, have been sufficient to bring them a very fair volume of orders, at the full prices. It seems now altogether improbable that there will be any further and general decline in steel prices. At the present time advances are not looked for, except perhaps in spots, but it is quite possible that the market will broaden so rapidly that some price advances will occur before the end of the year.

The Chemical Market

New York, June 26, 1919.

One of the most hopeful signs pointing toward a return to normality in the chemical trade is the increased domestic demand. This is attributed to the belief that the heavy stocks held by consumers when the armistice was signed have been used up.

Heavy Chemicals:—The most interesting development in the heavy chemical field is the strong position taken by caustic soda and soda ash. With the decision last week of the Alkali Export Association to advance caustic soda to $3.30 per cwt. f.a.s. a strengthening tendency immediately invaded the market. Caustic soda has been in steady demand for some time, particularly from Japan and South America, but recently, realizing that offerings in second-hands were rapidly disappearing, buyers came heavily into the market with the domestic call showing the greater strength. Soda ash is running a close second in point of demand from both export and domestic quarters, and following the example of caustic soda has registered an advance, now being quoted at $1.85-$1.90 per cwt.

The recent arrival of several thousand cases of potash from Japan, with rumors of the future heavy importation of Alsatian potash, continue the weak position of all potash products.

Muriatic and sulphuric acids are in good demand for

Cuba and South America. Last week domestic dye manufacturers were in the market for sulphuric in quantities. Citric acid is again weak due to heavy arrivals from abroad, in particular from Italy. Bleaching powder has advanced 2c, due to absorption of resale material.

Coal-Tar Products:—The improved tone of the crudes, noted in the last writing, stands at the same level. Benzol remains firm and is meeting a heavy demand from the rubber trade. As in the case of solvent naptha, xylol, commercial, has been advanced because of heavy demand and short stocks. The same is true of phenol, with drums at 10-13c. per lb.

Intermediates are keeping their stride and as the month closes a better general business is reported from all quarters. Not only is the domestic phase on the increase, but South America is purchasing in the local market. A leading manufacturer is receiving orders for August delivery of paratoluidine and para-nitro toluol, but doubts whether he can meet the heavy July demands. Alpha-naphthylamine is hitting a good place for domestic use while H-acid is in good demand for export, not in large quantities but from a number of sources.

Naval Stores:—Although for a time there were no spot stocks of turpentine on the market here, owing to the heavy call from Europe—particularly Scandinavia—new supplies have meantime arrived sufficient to take care of the normal domestic demand. During the past two months London has purchased approximately 60,000 bbl., which is thought to have filled her needs. Domestic buying has fallen off due to high prices. The result is an easier market.

The principal reason for the firm tone of rosins is the heavy export demand. With only one-half the normal crop of rosins being made this year a scarcity is predicted if present buying continues. However, with the exception of the pale grades, spot stocks here are normal. Savannah, where buying is also brisk, reports a shortage of pale grades. South America and the United Kingdom are the principal operators in rosins. Other naval stores show a slight rise in sympathy with rosins.

Crude Rubber:—It is estimated that present plantation stocks in London amount to 24,000 tons, with 10,000 tons in the Far East, and over 60,000 tons in the United States. In view of this condition, the market is weak, dealers being the principal operators. For the past week there has been an active dealers' demand for distant positions, presumably to cover short sales at a profit. Manufacturers, however, manifest no interest.

Paras are weak, in sympathy with planations. Manufacturers have fair-sized stocks on hand, future selling higher than spot. A Singapore cable reads: "Large holders primary markets weakening. Market weak.", while London wires: "Market stagnant awaiting political developments."

Oils:—The interrupted European demand remains the dominant factor, vegetable oils now going even into Germany and Austria. Domestic buyers realizing that the export demand will hold up the price are purchasing at prevailing levels. There is a scarcity not only of spot stocks, but of August and September futures. Linseed oil is particularly scare, owing to short crop of seed, and heavy demand. Although several shipments of seed have arrived from Argentina recently, linseed oil is firm at $1.88-$1.89 per gal.

The recent embargo placed by Spain on the export of olive oil is felt here in the small arrivals and the stiffening price. The commercial grade is held at $2.30 to $2.50 per gal.

During the past two weeks, oils, both vegetable and fish, have risen sharply. Winter pressed menhaden, quoted at the last writing at 90-92c per gal., has added 20c. to its market value. The foreign demand has developed to such an extent that surplus stocks are used up, necessitating reliance on the new catch of fish. Another factor in sending up fish oils is the fact that when these oils were at the lower level they were substituted wherever possible for the higher priced vegetable oils.

Shellac:—The shellac situation has not been aided by the information that the steamer "City of Rangoon," with about 5000 packages of shellac on board, had been in collision in mid-ocean with a Brazilian steamer and had put back to Gibraltar. While small amounts continue to arrive all go to fill back orders. Most dealers have stopped quoting and are merely delivering on previous sales or alloting small quantities to their regular trade. One dealer, however, is quoting orange, superfine at $1-$1.15, spot, in one and two-bag lots; futures, Sept. to Dec. deliveries, TN, 72-75c, orange, superfine, 80-85c, and bone dry at 80-85c. It is not until September that any relief is expected.

Waxes:—Firmer tone and higher prices characterize the wax market, carnauba and stearic acid showing the sharpest increase. The Brazilian crop of carnauba is exceedingly light, and trading has become speculative, with Europe buying heavily. Three shipments of this wax are expected soon, but they will have little effect, being already sold. With production cut because of the warm weather and a shortage of basic manufacturing supplies, stearic acid is scarce and higher in price. With a general shortage of spot stocks prices of waxes are expected to mount still higher.

St. Louis, Mo., June 23.

The past two weeks have shown a steadily increasing activity in most branches of the heavy chemical market, according to local producers. Demand for sulphuric acid from the fertilizer manufacturers and for sodium bisulphate or nitre cake, especially, has grown to such proportions that one of the best informed men on the subject characterized the market as having "gone crazy." Producers of nitre cake say that there is no accounting for the present demand for this item which until recently was "dumped" for indefinite storage at plants where it was a by-product. A nearby producer is understood to be digging into such a storage pile of nitre cake for the first time in years.

Sulphuric Acid—Sixty per cent sulphuric acid was the most active item on the list here in the last two weeks. This may be accounted for by the fact that producers who asked $12.50 to $14 a ton several weeks ago, on noting the reluctance to buy, accepted contracts at $11.50. Heavy sales at this figure are reported. The 66 per cent grade, still quoted at $18 a ton, is stationary, but firm. The same is true of oleum.

Muriatic Acid—A large number of sales is reported in this commodity at the quotation of the previous report, $22 a ton for the 18 per cent grade. The starch, glucose and graniteware people are alike actively in the market for the chemical.

Sodium Sulphate (*Salt cake*)—The demand for this item fell off during the fortnight sufficiently to induce manufacturers to offer it at a dollar concession, or $18 to $20 a ton, according to grade and quantity.

Sodium Bisulphate (*Nitre Cake*)—A sudden and unaccountable demand developed in the last week or two, but heavy stocks maintained the price at $4 to $5 a ton.

Nitric Acid—This branch of the market in comparison to the others is quiet. The price, however, remains firm at 10 to 10½ cents per pound for the 38 Baumé.

Zinc Chloride—In view of the conditions in railroad circles this item (used largely for treating ties) is considered fairly active by producers here. Compared to previous week, however, the demand has fallen off somewhat. The price remains stationary at 4 cents for the 50 per cent solutions.

Zinc Oxide—Developments of unusual importance are expected in the Mid-West zinc-oxide market momentarily, as a result of the action of Eastern producers in doing away with quarterly price announcements. While no definite statement of policy is forthcoming today, indications are that this market will now become wholly competitive with price changes developing from day to day or at most from week to week, rather than from quarter to quarter, as in previous years. The present quarter expires on July 1 and the basis of doing business in this item is to be readjusted within the next few days. With this condition prevailing an almost total cessation of buying would be expected. Producers, however, report an excellent demand. Prices at which current business is being done range from 8 to 9 cents a pound according to the lead-sulphate content in car lots and half a cent additional for smaller quantities. It is rumored that the inauguration of an open market will result in an advance in prices of this item.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET JUNE 25, 1919

Acetic anhydride	lb.	$0.52	—	$0.60
Acetone	lb.	.14	—	.15½
Acid, acetic, 28 per cent	cwt.	2.50	—	3.00
Acetic, 56 per cent	cwt.	5.50	—	6.00
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00	—	14.00
Boric, crystals	lb.	.13½	—	.14½
Boric, powder	lb.	.13¾	—	.14½
Hydrochloric, tech. 20 deg.	cwt.	1.50	—	3.00
Hydrofluoric, 52 deg.	lb.	.10	—	.11
Lactic, 44 per cent. tech.	lb.	.14	—	.17
Lactic, 22 per cent. tech.	lb.	.05	—	.06
Molybdic, C. P.	lb.	4.50	—	5.50
Nitric, 40 deg.	lb.	.07	—	.08
Nitric, 42 deg.	lb.	.07	—	.08
Oxalic, crystals	lb.	.23	—	.28
Phosphoric, Ortho, 50 per cent. solution	lb.	.07½	—	.10
Picric	lb.	.30	—	.40
Pyrogallic, resublimed	lb.	2.30	—	2.55
Sulphuric, 60 deg., tank cars	ton	11.00	—	13.00
Sulphuric, 60 deg., drums	ton	17.00	—	.....
Sulphuric, 60 deg., carboys	ton	20.00	—	.....
Sulphuric, 66 deg., tank cars	ton	16.00	—	18.00
Sulphuric, 66 deg., drums	ton	21.00	—	.....
Sulphuric, 66 deg., carboys	ton	25.00	—	.....
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00	—	22.00
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00	—	.....
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00	—	.....
Tannic, U. S. P.	lb.	1.30	—	1.40
Tannic (tech.)	lb.	.42	—	.60
Tartaric, crystals	lb.	.82	—	.85
Tungstic, per lb. of WO_3	lb.	1.20	—	1.40
Alcohol, Ethyl	gal.	4.00	—	4.85
Alcohol, Methyl	gal.	1.20	—	1.23
Alum, ammonia lump	lb.	.03½	—	.04½
Alum, potash lump	lb.	.08¾	—	.10
Alum, chrome lump	lb.	.15	—	.....
Aluminium sulphate, commercial	lb.	.01¾	—	.03
Aluminium sulphate, iron free	lb.	.02¾	—	.03
Aqua ammonia, 26 deg., drums	lb.	.06¾	—	.08
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.30	—	.....
Ammonium carbonate, powder	lb.	.12½	—	.13½
Ammonium chloride, granular (white salammoniac)	lb.	.13	—	.14
Ammonium chloride, granular (gray salammoniac)	lb.	.13	—	.14
Ammonium nitrate	lb.	.17	—	.20
Ammonium sulphate	lb.	.05	—	.06
Amyl acetate	gal.	3.50	—	3.75
Arsenic, oxide, lumps	lb.	.09	—	.09½
Arsenic, sulphide, powdered	lb.	.30	—	.32
Barium chloride	ton	80.00	—	90.00
Barium dioxide (peroxide)	lb.	.19	—	.24
Barium nitrate	lb.	.10	—	.11
Barium sulphate (precip.) (blanc fixe)	lb.	.01¾	—	.03
Bleaching powder (see calcium hypochlorite)		.....	—	.....
Blue Vitriol (see copper sulphate)		.....	—	.....
Borax (see sodium borate)		.....	—	.....
Brimstone (see sulphur, roll)		.....	—	.....
Bromine	lb.	.40	—	.50
Calcium acetate	lb.	.02	—	.02½
Calcium carbide	lb.	.05½	—	.06
Calcium chloride, fused, lump	ton	19.00	—	25.00
Calcium chloride, granulated	lb.	.01¾	—	.02
Calcium hypochlorite (bleaching powder)	cwt.	1.60	—	2.00
Calcium peroxide	lb.	1.50	—	1.70
Calcium phosphate, monobasic	lb.	.22	—	.23
Calcium sulphate, precipitated	lb.	.10	—	.20
Carbon bisulphide	lb.	.05½	—	.06
Carbon tetrachloride, drums	lb.	.11	—	.14
Carbonyl chloride (phosgene)	lb.	.75	—	1.00
Caustic potash (see potassium hydroxide)		.....	—	.....
Caustic soda (see sodium hydroxide)		.....	—	.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05	—	.08
Cobalt oxide	lb.	1.60	—	1.65
Copperas (see iron sulphate)		.....	—	.....
Copper carbonate, green precipitate	lb.	.28	—	.31
Copper cyanide	lb.	.65	—	.70
Copper sulphate, crystals	lb.	.07	—	.08
Cream of tartar (see potassium bitartrate)		.....	—	.....
Epsom salt (see magnesium sulphate)		.....	—	.....
Formaldehyde, 40 per cent	lb.	.20	—	.21
Glauber's salt (see sodium sulphate)		.....	—	.....
Glycerine	lb.	.20	—	.23
Iodine, resublimed	lb.	4.25	—	4.30
Iron oxide, red	lb.	.03	—	.18
Iron sulphate (copperas)	cwt.	1.00	—	1.75
Lead acetate, normal	lb.	.12¾	—	.15
Lead arsenate (paste)	lb.	.15	—	.18
Lead nitrate, crystals	lb.	.85	—	.86½
Litharge	lb.	.09½	—	.10½
Lithium carbonate	lb.	1.50	—	.....
Magnesium carbonate, technical	lb.	.12	—	.14
Magnesium sulphate, U. S. P.	100 lb.	2.70	—	3.00
Magnesium sulphate, commercial	100 lb.	2.50	—	2.60
Nickel salt, double	lb.	.13	—	.15
Nickel salt, single	lb.	.11½	—	.14
Phosgene (see carbonyl chloride)		.....	—	.....
Phosphorus, red	lb.	.55	—	.65
Phosphorus, yellow	lb.	.35	—	.39
Potassium bichromate	lb.	.26	—	.33
Potassium bitartrate (cream of Tartar)	lb.	.52½	—	.55
Potassium bromide, granular	lb.	.49	—	.50
Potassium carbonate, U. S. P.	lb.	.60	—	.70
Potassium carbonate, crude	lb.	.11	—	.14
Potassium chlorate, crystals	lb.	.25	—	.31
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium hydroxide (caustic potash)	lb.	.35	—	.45
Potassium iodide	lb.	3.30	—	3.40
Potassium nitrate	lb.	.19	—	.22
Potassium permanganate	lb.	.55	—	.60
Potassium prussiate, red	lb.	.80	—	.95
Potassium prussiate, yellow	lb.	.27	—	.40
Potassium sulphate	ton	225.00	—	.....
Rochelle salts (see sodium potas. tartrate)		.....	—	.....
Salammoniac (see ammonium chloride)		.....	—	.....
Sal soda (see sodium carbonate)		.....	—	.....
Salt cake	ton	10.00	—	15.00
Silver cyanide	oz.	1.19	—	.....
Silver nitrate	oz.	.69	—	.71
Soda ash, light	100 lb.	$1.75	—	$1.88
Soda ash, dense	100 lb.	2.00	—	2.25
Sodium acetate	lb.	.06	—	.08
Sodium bicarbonate	100 lb.	2.25	—	2.50
Sodium bichromate	lb.	.07¾	—	.09
Sodium bisulphate (nitre cake)	ton	3.00	—	10.00
Sodium bisulphite	lb.	.05	—	.07
Sodium borate (borax)	lb.	.07½	—	.08
Sodium carbonate (sal soda)	100 lb.	1.30	—	1.60
Sodium chlorate	lb.	.15	—	.18
Sodium cyanide	lb.	.30	—	.31
Sodium fluoride	lb.	.14	—	.15
Sodium hydroxide (caustic soda)	100 lb.	3.00	—	3.50
Sodium molybdate	lb.	2.50	—	.....
Sodium nitrate	100 lb.	3.25	—	4.07½
Sodium nitrite	lb.	.11	—	.13
Sodium peroxide, powdered	lb.	.25	—	.30
Sodium phosphate, dibasic	lb.	.03¾	—	.05
Sodium potassium tartrate (Rochelle salts)	lb.	.43	—	.45½
Sodium prussiate, yellow	lb.	.17½	—	.20
Sodium silicate, solution (40 deg.)	lb.	.01¾	—	.02¾
Sodium silicate, solution (60 deg.)	lb.	.02¾	—	.04¾
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.25	—	1.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.04½	—	.05
Sodium sulphite, crystals	lb.	.03½	—	.04
Strontium nitrate, crystals	lb.	.25	—	.28
Sulphur chloride	lb.	.05	—	.05½
Sulphur, crude	ton	32.00	—	35.00
Sulphur dioxide, liquid, cylinders	lb.	.10	—	.12
Sulphur (sublimed), flowers	100 lb.	3.05	—	3.60
Sulphur, roll (brimstone)	100 lb.	2.70	—	3.15
Tin bichloride (stannous)	lb.	.22½	—	.25
Tin oxide	lb.	.60	—	.....
Zinc carbonate, precipitate	lb.	.18	—	.20
Zinc chloride, gran	lb.	.12¾	—	.14
Zinc cyanide	lb.	.49	—	.50
Zinc dust	lb.	.09	—	.11
Zinc oxide, dry American	lb.	.09½	—	.11½
Zinc sulphate	lb.	.03¾	—	.04

Coal Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.35	—	.50
Aniline oil, drums extra	lb.	.22	—	.24
Aniline salts	lb.	.28	—	.33
Anthracene, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.00	—	1.15
Benzidine, base	lb.	.95	—	1.15
Benzidine, sulphate	lb.	.90	—	1.10
Benzoic acid, U. S. P.	lb.	1.00	—	1.10
Benzoate of soda, U. S. P.	lb.	.95	—	1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.24	—	.28
Benzol, 90%, in drums (100 lb.)	gal.	.23½	—	.27
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	4.00	—	4.50
Beta naphthol, sublimed	lb.	.75	—	.80
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85	—	.90
Cresylic acid, 95-97%, dark, in drums	gal.	.80	—	.85
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.50	—	2.25
Dimethylaniline	lb.	.50	—	.57
Dinitrobenzol	lb.	.25	—	.37
Dinitroclorbenzol	lb.	.25	—	.28
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.30	—	.32
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25% tar acids, car lots, in drums	gal.	.38	—	.46
Diphenylamine	lb.	.70	—	.75
H-acid	lb.	1.75	—	2.25
Metaphenylenediamine	lb.	1.20	—	1.80
Monochlorbenzol	lb.	.10	—	.14
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline, crushed in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.06½	—	.07½
Naphthaline, balls	lb.	.09¾	—	.10
Naphthionic acid, crude	lb.	1.00	—	1.25
Nitrobenzol	lb.	.13	—	.15
Nitro-naphthaline	lb.	.35	—	.45
Nitro-toluol	lb.	.17	—	.20
Ortho-amidophenol	lb.	6.00	—	.....
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	1.25	—	.....
Ortho-toluidine	lb.	.37	—	.45
Ortho-nitro-toluol	lb.	.27	—	.40
Para-amidophenol, base	lb.	2.60	—	3.50
Para-amidophenol, H. Cl.	lb.	2.75	—	3.25
Para-dichlor-benzol	lb.	.06	—	.10
Paranitraniline	lb.	1.00	—	1.25
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	3.00	—	3.25
Para toluidine	lb.	1.50	—	1.75
Phthalic anhydride	lb.	1.75	—	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10	—	.13
Pyridin	gal.	2.50	—	.....
Resorcin, technical	lb.	3.50	—	3.75
Resorcin, pure	lb.	6.50	—	7.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.20	—	.30
Salicylic acid, U. S. P.	lb.	.25	—	.35
Salol	lb.	.75	—	80
Solvent naphtha, water white, in drums, 100 gal.	gal.	.20	—	.27
Solvent naptha. crude, heavy, in drums, 100 gal.	gal.	.18	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30
Tolidine	lb.	1.75	—	2.50
Toluidine, mixed	lb.	.45	—	.80
Toluol, in tank cars	gal.	.22	—	.24
Toluol, in drums	gal.	.23	—	.30
Xylidine, drums, 100 gal.	lb.	.40	—	.45
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.23	—	.27
Xylol, commercial, in tank cars	gal.	.22	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.42 — $0.44
Beeswax, refined, yellow	lb.	.48 — .50
Beeswax, white pure	lb.	.65 — .68
Carnauba, No. 1	lb.	.88 — .92
Carnauba, No. 2, regular	lb.	.66 — .74
Carnauba, No. 3, North Country	lb.	.55 — .56
Japan	lb.	.18½ — .20
Paraffine waxes, crude match wax (white) 105-110 m.p	lb.	.06 — .07½
Paraffine waxes, crude, scale 124-126 m.p	lb.	.07 — .....
Paraffine waxes, refined, 118-120 m.p	lb.	.08½ — .08½
Paraffine waxes, refined, 128-130 m.p	lb.	.09½ — .10
Paraffine waxes, refined, 133-135 m.p	lb.	.11½ — .12
Paraffine waxes, refined, 135-137 m.p	lb.	.12½ — .....
Stearic acid, single pressed	lb.	.20 — .21½
Stearic acid, double pressed	lb.	.23 — .23½
Stearic acid, triple pressed	lb.	.24 — .25

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$0.70
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, ref., sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.58
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.34
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.61
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.24
Hardwood oil, f.o.b. Mich., sp. gr., 1.06-1.08	gal.	.24
Pinewood creosote, ref	gal.	.48

Naval Stores

The following prices are f.o.b., New Nork, for carload lots.

Rosin B-D, bbl	280 lb.	$15.00 — $16.25
Rosin E-I	280 lb.	16.50 — 16.90
Rosin K-N	280 lb.	16.90 — 17.75
Rosin W. G.-W. W	280 lb.	17.75 — 18.60
Wood rosin, bbl	280 lb.	15.00 — ......
Spirits of turpentine	gal.	1.10 — ......
Wood turpentine, steam dist	gal.	1.07 — ......
Wood turpentine, dest. dist	gal.	.98 — ......
Pine tar pitch, bbl	200 lb.	8.00 — 8.25
Tar, kiln burned, bbl. (500 lb.)	bbl.	12.50 — 13.50
Retort tar, bbl	280 lb.	13.50 — 14.50
Rosin oil, first run	gal.	.81 — .83½
Rosin oil, second run	gal.	.83 — .85½
Rosin oil, third run	gal.	.85 — 1.02½
Rosin oil, fourth run	gal.	.88 — 1.05

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha. steel bbls. (85 lb.)	gal	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.55 —0.55½
Upriver coarse	lb.	.33 — .34
Upriver caucho ball	lb.	.33½— .34
Plantation—First latex crepe	lb.	.39½— .40½
Ribbed smoked sheets	lb.	.38½— .39
Brown crepe, thin, clean	lb.	.34 — .36
Amber crepe No. 1½	lb.	.36 — .38

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.19 — $0.21
Castor oil, AA, in bbls	lb.	.21 — .23
China wood oil, in bbls	lb.	.21 — .22
Cocoanut oil, Ceylon grade, in bbls	lb.	.19½ — .20
Cocoanut oil, Cochin grade, in bbls	lb.	.21 — .22
Corn oil, crude, in bbls	lb.	.20½ — .21
Cottonseed oil, crude (f.o.b. mill)	lb.	.19 — .22
Cottonseed oil, summer yellow	lb.	.26 — .27
Cottonseed oil, winter yellow	lb.	.26 — .27
Linseed oil, raw, car lots	gal.	1.88 — 1.90
Linseed oil, raw, tank cars	gal.	1.84 — 1.90
Linseed oil, boiled, car lots	gal.	1.90 — 1.93
Olive oil, commercial	gal.	2.30 — 2.40
Palm, Lagos	lb.	.17 — .18
Palm, bright red	lb.	.17 — .18
Palm, Niger	lb.	.16 — .16½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.22 — .23½
Peanut oil, refined, in bbls	lb.	.26 — .27
Rapeseed oil, refined in bbls	gal.	1.55 — 1.60
Rapeseed oil, blown, in bbls	gal.	1.60 — 1.65
Soya bean oil (Manchurian), in bbls., N. Y	lb.	.19 — .19½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.16½ — .17

FISH

Winter pressed Menhaden	gal.	$1.10 — ......
Yellow bleached Menhaden	gal.	1.12 — 1.15
White bleached Menhaden	gal.	1.14 — 1.20
Blown Menhaden	gal.	1.18 — 1.25

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00 — $36.00
Barytes, off color	ton	22.00 — 27.00
Blanc fixe, dry	lb.	.03½ — .04½
Blanc fixe, pulp	ton	30.00 — 45.00
Casein	lb.	.16 — .18
Chalk, English, extra light	lb.	.05 — .07
Chalk, English, light	lb.	.04½ — .06
Chalk, English, dense	lb.	.04 — .05
China clay (Kaolin), imported, lump	ton	25.00 — 35.00
China clay (Kaolin), imported, powdered	ton	30.00 — 60.00
China clay (Kaolin), domestic, lump	ton	10.00 — 20.00
China clay (Kaolin), domestic, powdered	ton	25.00 — 40.00
Feldspar	ton	11.00 — 15.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	$30.00 — $35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00 — 45.00
Fuller's earth, domestic, powdered	ton	30.00 — 40.00
Fuller's earth, imported, powdered	ton	...... — .....
Pumice stone, imported	lb.	.03 — .06
Pumice stone, domestic	lb.	.02½ — .....
Shellac, TN	lb.	.60 — .....
Shellac, D.C	lb.	...... — .....
Shellac, V. S. O	lb.	1.15 — .....
Shellac, Diamond I	lb.	...... — .....
Shellac, orange, fine	lb.	.88 — .....
Shellac, orange, superfine	lb.	1.00 — 1.15
Shellac, A.C. garnet	lb.	.90 — .....
Shellac, bleached, bone dry	lb.	1.15 — .....
Shellac, bleached, fresh ground	lb.	1.00 — .....
Soapstone	ton	15.00 — 25.00
Talc, domestic	ton	16.00 — 60.00
Talc, imported	ton	55.00 — 60.00

Refractories

Following prices are f. o. b. works:

Chrome brick	net ton	90–100 at Chester, Penn.
Chrome cement	net ton	45–50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35–45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30–35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50–55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in	net ton	80–90 at Chester, Penn.
Silica brick	net ton	41–45 at Mt. Union, Penn.

Ferro-alloys

All prices f. o. b. works.

Ferro-carbon-titanium, 15–18%, f.o.b. Niagara Falls, N. Y	net ton	$220.00 — ....
Ferro-chrome, per lb. of Cr. contained, 6–8% carbon	lb	.32 — $0.40
Ferro-chrome, per lb. of Cr. contained, 2–4% carbon	lb.	.70 — ....
Ferro-manganese, 70-80% Mn	gross ton	100.00 — 125.00
Spiegeleisen, 16-20% Mn	gross ton	35.00 — 50.00
Ferro-molybdenum, per lb. of Mo	lb.	2.00 — 3.00
Ferro-silicon, 50%	gross ton	90.00 — 115.00
Ferro-silicon, 75%	gross ton	150.00 — 175.00
Ferro-silicon, 10–15%	gross ton	45.00 — 60.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.30 — 1.60
Ferro-uranium, 35-50%, of U	lb.	7.00 — ......
Ferro-vanadium, 30-40%, per lb. of contained V.	lb.	5.50 — 7.00

Resales and overstocks make above prices approximate.

Ores and Semi-finished Products

Chrome ore, 35-40%, Cr_2O_3	unit	$0.70
Chrome ore, 48% and over	unit	.80 —
Coke, foundry, f.o.b. mines	net ton	5.00 — $5.50
Coke, furnace, f.o.b. mines	net ton	4.50 — 5.00
Petroleum coke, f.o.b. Atlantic seaboard	net ton	16.00 — 16.50
Fluorspar, gravel, f.o.b. mines	net ton	20.00 — 25.00
Manganese ore, 45% Mn and over	unit	.60 — .65
Manganese ore, chemical (MnO_2)	gross ton	60.00 — 70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75 — .85
Tungsten, Scheelite, 60% WO_3 and over per unit of WO_3	unit	9.00 — 11.50
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50 — 8.00
Uranium oxide, 96%	lb.	...... — .....
Vanadium pentoxide, 99%	lb.	6.00 — .....
Pyrites, foreign, lump	unit	.15 — .....
Pyrites, foreign, fine	unit	.15 — .....
Pyrites, domestic, fine	unit	.14 — .....
Ilmenite, 50% TiO_2	net ton	30.00 — .....
Rutile, 95% TiO_2	net ton	200.00 — .....
Carnotite, mimmum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75 — 3.00

Resales and overstocks make above prices approximate.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container 300	bbl.	2.65
Common brick, at dock	M.	15.00
Hollow building tile, At factory, Perth Amboy, N. J. } 8x12x12	M.	194.40
Hollow building tile, At factory, Perth Amboy, N. J. } 12x12x12	M.	291.60
Yellow pine, 3x4 to 8x8, 20-24 ft. long	M.	40.00
Yellow pine, 3x4 to 8x8, 20-24 ft. long at Chicago	M.	39.50
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis	M.	37.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	60.00
Roofings, tar pitch (in 400-lb. bbl.)	ton	21.00
Roofings, asphalt pitch	ton	34.00
Roofings, asphalt felt	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft.		2.00
Roofings, slate-finished shingles, 100 sq.ft.		5.00
Linseed oil, raw in barrels	gal.	1.93
Linseed oil, 5 gal. cans	gal.	2.06
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanised	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanised corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

DUNCAN—The Ash Peak Mines Co. plans to build a mill to have a yearly capacity of 45,000 tons. A. Murphy, superintendent.

GLOBE—The Gila Monster Co. plans to build a 10 stamp mill and is in the market for a crusher, two tables, six tanks and an 80 hp. engine. Estimated cost, $50,000. W. H. Seaman, superintendent. Noted May 15.

GLOBE—The Jumbo Mining Co. plans to build a 25-ton cyanide mill to handle tailings. W. T. Bessonnette, Waco, Tex., superintendent.

MIAMI—The Greater Miami Mining & Milling Co. plans to build a 100-ton concentration mill.

MIAMI—The Miami Mining & Milling Co. plans to build a 50-ton concrete flotation mill at Dook Station, near the Arizona Eastern Railway.

TUSCON—The Yellow Bird Mining Co. plans to build a silver lead furnace at its property 32 miles west of Tuscon to treat 50 tons daily. S. W. Purcell, manager.

WINKLEMAN—The Aztlan Mining Co. will build a 100-ton mill and is in the market for equipment for same. Estimated cost, $150,000. H. Whitcomb, manager.

California

AVALON—The city voted $55,000 bonds for the construction of a gas plant. A. B. Waddingham, Tajo Building, Los Angeles, city engineer.

BISHOP—A. D. Schiveley, town clerk, rejected bids opened June 2 for the construction of a sanitary sewerage system and sewage treatment tank. Estimated cost, $35,000. New bids will soon be received. Olmsted & Gillelen, 1112 Hollingsworth Building, Los Angeles, engineers.

WASHINGTON — W. F. McCutcheon, San Francisco, plans to rebuild its 40-stamp mill, compressor building, etc., near here, recently destroyed by fire. W. L. Williamson, superintendent.

Connecticut

MIDDLETOWN—The trustees of the Wesleyan University plan to build a new chemical laboratory building on the campus. Estimated cost, $100,000.

NEW HAVEN—The Seamless Rubber Co., 534 Congress St., has awarded the contract for the construction of a plant on Hallock Ave. to the Aberthaw Construction Co., 27 School St., Boston, Mass. Estimated cost, $500,000.

District of Columbia

WASHINGTON—The Army War College received bids for the construction of a photographic laboratory, from E. Diebitsch, 383 Madison Ave., New York, N. Y., $60,994 (100 days); Weller Construction Co., 816 14th St., $65,893 (160 days); Piel Construction Co., 2519 Edmonston Ave., Baltimore, Md., $68,750 (120 days).

Florida

WEST PALM BEACH—The City Council will soon receive bids for the construction of a large filtration plant. G. W. Simmons, Jacksonville, engineer.

Indiana

INDIANAPOLIS—The Board of Sanitary commissioners, City Hall, will receive bids until July 11 for the construction of a sewage disposal plant for the sanitary district. J. A. Craven, secretary.

Iowa

CLINTON—The Board of Education will receive bids in August for the construction of a two-story, 206 x 226-ft. high school. Plans include a chemistry room, physics supply room, etc. Total estimated cost, $300,000. A. H. Paddock, secretary. Miller, Fullenwider & Dowling, 6 North Michigan Ave., Chicago, Ill., architects.

Louisiana

BATON ROUGE—The Aluminum Ore Co., St. Louis, Mo., plans to build a bauxite ore refinery here.

Maryland

MD., CANTON (Baltimore P. O.)—The Porcelain Enamel & Manufacturing Co., O'Donnell and 8th Sts., will build a 1-story, 100 x 110-ft. addition to its enameling plant. Estimated cost, $12,500.

HIGHLANDTOWN (Baltimore P. O.)—Jones & Lamb Co., Pennsylvania and Fulton Aves., Baltimore, will soon receive bids for converting the plant of the Monumental Brewery Co., on Lombard St., into a meat packing plant and oil refinery. Estimated cost, $500,000. C. B. Comstock, 110 West 40th St., New York, N. Y., engineer. Noted May 15.

SOUTH BALTIMORE (Baltimore P. O.)—The Standard Guano Co., 1214 Continental Building, Baltimore, will build a 2-story, 104 x 400-ft. fertilizer factory on Aspen St., near Pennington Ave. Estimated cost, $96,000. P. S. Gilchrist, 601 Park Ave., Charlotte, N. C., architect.

Massachusetts

FITCHBURG—Crocker, Burbank & Co., Inc., 545 Westminster St., will soon receive bids for the construction of a 2-story, 60 x 200-ft. factory for the manufacture of paper. Estimated cost, $100,000.

MALDEN—The Boston Dye House has awarded the contract for the construction of a 3-story, 40 x 100-ft. dye house, a 1-story, 30 x 60-ft. naphtha house, and a 1-story garage, on Main and Eastern Sts., to C. H. Tenney & Co., Devonshire. Estimated cost, $50,000.

WESTFIELD—The National Pulp Corporation, 505 5th Ave., New York City, N. Y., plans to build a plant on the Westfield River. Estimated cost, $200,000.

Michigan

ESCANABA—The Escanaba Wood Fibre Co. plans to build a 3-story paper mill. Estimated cost, $750,000.

SAGINAW—The Saginaw News-Courier, South Wart St., plans to build a 1- and 2-story, 48 x 132-ft. newspaper plant on South Washington St. Cowles & Mutscheller, 114 North Washington St., architect.

Missouri

ST. LOUIS—The Mineral Refining & Chemical Corp., Iron Mountain Tracks and River Des Peres, is in the market for chemical and mineral dryers.

New Jersey

JAMESBURG—The Department of Agriculture, 142 West State St., Trenton, will receive bids until June 25 for the construction of a sewerage system at the State Home for Boys, to include a 54-ft. stone filter bed, sludge bed, etc. Estimated cost, $10,000. F. H. Bent, 142 West State St., Trenton, engineer.

NEWARK — The Wallington Leather Works, 42 Kent St., has awarded the contract for the construction of a 2 story, 48 x 50-ft. tannery, to J. R. Robinson, 274 South St. Estimated cost, $8,000.

PALMYRA—The city plans to build a sanitary sewerage system to include a combined sewage pumping station and disposal works for treating sewage of both Riverton and Palmyra. Estimated cost, $125,000. Remington & Vosbury, 601 Market St., Camden, engineers.

TRENTON—The Albano Manufacturing Co., 40 General Green Ave., plans to build a 1-story, 60 x 125-ft. factory for the manufacture of shoe paste. Estimated cost, $12,000. P. L. Fowler, 317 Broad St. Bank Building, architect.

WESTMONT—The city plans to build a sanitary sewerage system to include sewage ejector station and treatment works. Remington & Vosbury, 601 Market St., Camden, engineers.

New York

LONG ISLAND CITY—The Patterson-Sargent Co., 8 Jay St., New York City, will soon receive bids for the construction of a 4-story, 40 x 110-ft. addition to its paint factory on Van Dam St. and Borden Ave. here. Estimated cost, $200,000. Ballinger & Perrott, 47 West 34th St., New York City, engineer.

NORTH TONAWANDA — The Buffalo Bolt Co., Tonawanda, has awarded the contract for the construction of an 80 x 170-ft. addition to its rolling mill and 40 x 340-ft. addition to its tumbling room, to the Lackawanna Bridge Co., Bell and Abbey Sts., Buffalo. Estimated cost, $60,000.

PIERREPONT MANOR—The Northern New York Milk Co., recently incorporated with $500,000 capital stock, will install laboratory equipment for both dry and condensed milk plant, in connection with the milk station, evaporating plant and milk shipping station which it plans to build. Estimated cost, $200,000. Address F. P. Redfield, Adams, director.

SYRACUSE—The B. G. H. Metal Manufacturing Co., 106 South State St., has purchased a site at 108-112 South State St., and plans to build a 3-story plant. Estimated cost, $25,000. W. E. Sias, secretary.

North Carolina

RALEIGH—The International Vegetable Oil Co. will build an addition to its oil plant, here. Estimated cost, $30,000. W. F. Marsh, manager.

Ohio

CINCINNATI—The Chas. Boldt Paper Mill Co., 5500 Eastern Ave., plans to build a 1-story, 48 x 106-ft. and 46 x 320-ft. addition to its paper mill. C. Boldt, president.

COLUMBUS—M. Peterman, architect, Rector Building, is receiving bids for the construction of a 1- and 2-story addition to the cleaning plant of the Buckeye Cleaning Co., Main St. and Alum Creek.

DAYTON—The Dayton Oxygen & Hydrogen Products Co., U. B. Annex, has awarded the contract for the construction of a 2-story, 60 x 180-ft. factory on South Broadway, to the Blanchard Building Co., Dayton. Estimated cost, $45,000.

MARION—B. H. Bair plans to build two buildings, 2-story, each 20 x 20 ft., for dry cleaning plant. F. D. Jacobs, Church St., architect.

MIDDLETOWN — The Gardner-Harvey Paper Co. has awarded the contract for the construction of a 2-story, 35 x 250-ft. paper mill, to Frank Hill Smith, Inc., West 3rd St., Dayton. Estimated cost, $30,000.

SPRINGFIELD—The Ohio Steel Foundry Co., Lagonda Ave. and Gothic St., will build a welding building, garage and research laboratory. Estimated cost, $25,000.

Oklahoma

ENID—The city plans an election soon to vote on $1,000,000 bonds; $300,000 to be used for waterworks improvements and extensions, and $175,000 for the construction of a sewage disposal plant, etc. Black & Veatch, Interstate Building, Kansas City, Mo., engineers.

OKLAHOMA CITY—The Hazelrigg Laboratories, incorporated with $50,000 capital by V. T. Hazelrigg, president, and Dr. J. E. Harbison, 310 Mercantile Building, treasurer, plans to build a plant. Project includes the largest chemical, bacteriological and serological laboratories in the Southwest.

TULSA—The trustees of the Henry Kendall College, Cleland and 7th Sts., are having revised plans prepared for the construction of a gymnasium. Plans include the installation of a filtration plant, etc. C. E. Buchner, chairman.

Oregon

CORVALLIS—The Board of Regents of the State Agricultural College has awarded the contract for the construction of a 2-story, 56 x 220-ft. engineering laboratory on the college campus, to Snook & Travers, Albany, $69,987. Noted June 15.

Pennsylvania

FULTON—The National Metal & Moulding Co., Fulton Building, Pittsburgh, plans to build a 1-story, 130 x 250-ft. addition to its plant, here.

ALTO—The State Department of Health, Harrisburg, has awarded the contract for constructing and equipping extensions to the sewage disposal plant at the State Sanitarium for Tuberculosis, near here, to Simpson & Brown, 90 West St., New York City, $23,031.

PHILADELPHIA—The Keystone Pure Oil Co., Broad St., below Huntington St., has awarded the contract for the construction of a 2-story, 76 x 150-ft. factory, to F. A. Havens, 845 North 19th St. Estimated cost, $40,000.

PITTSBURGH—The Damascus Bronze Co., 928 South St., plans to build an 80 x 80-ft. addition to its plant.

South Carolina

ANDREWS—The City Council will soon receive bids for laying sewer mains and constructing a sewage disposal plant. Estimated cost, $50,000. Tomlinson Engineering Co., Loan & Exchange Bank Building, Columbia, engineers.

BATESBURG—The city plans an election July 11, to vote on $40,000 bonds for the construction of a sewerage system, to include a septic tank, etc.

Tennessee

KNOXVILLE—The Day Pulverizer Co. plans to build a 1-story addition to its plant, also install machinery in same.

Texas

WICHITA FALLS—The Committee of the Northwest Texas Insane Asylum will soon award the contract for the construction of an administration building at the asylum here, including sewage disposal plant, etc. Total estimated cost, $350,000. C. H. Page & Bros., Austin National Bank Building, Austin, architect.

Washington

SEATTLE—Dr. J. Wilkins, Cobb Building, has awarded the contract for the construction of a 3-story, 34 x 60 x 70-ft. hospital on 16th and John Sts., to P. T. Bratt, 4902 Phinney Ave. Plans include the installation of an X-ray laboratory. Estimated cost, $55,000. J. R. Nevins, Hoge Building, architect.

West Virginia

CHARLESTON — The Superior Red Granite Co., 813 Kanawha Building, plans to build a granite crushing plant, and is in the market for 4 crushers having a daily capacity of eight cars of granite.

WESTON—The State Board of Control, Charleston, has awarded the contract for the construction of a sewage disposal plant at the Weston State Hospital, here, to C. E. Collins, Drexel Building, Philadelphia, Pa. Estimated cost, $45,000. Noted June 1.

Wisconsin

CARROLLVILLE (Otjen P. O.)—The United States Fertilizer Co., c/o the United States Glue Co., will soon award the contract for the construction of a 2- and 3-story, 67 x 219 and 50 x 50-ft. fertilizing plant. Estimated cost, $100,000. H. J. Esser, Camp Building, Milwaukee, architect.

GREEN BAY—The Fort Howard Paper Co. has awarded the contract for the construction of a 1-story, 49 x 135-ft. factory, to Ludolph Hansen, 114 South Maple St. Estimated cost, $45,000. Noted April 1.

MILWAUKEE—The Pfister & Vogel Leather Co., Virginia St., has awarded the contract for the construction of a 2-story, 60 x 180-ft. addition to its tannery on Bay View St., to C. A. Kleppe, 1026 1st St. Estimated cost, $30,000.

TWO RIVERS—The Board of Education will install laboratory equipment in the 3-story, 80 x 155-ft. high school which it plans to build on Main St. Total estimated cost, $125,000. T. D. Chubb, 109 Dearborn St., Chicago, Ill., architect.

Nova Scotia

TIVERTON—The Digby Fish Meal Co. will soon receive bids for the construction of a 3-story, 60 x 100-ft. factory on Queen St. for the manufacture of fish meal and extraction of oil. Estimated cost, $25,000.

Ontario

KINGSTON—The Department of Public Works, Ottawa, will soon award the contract for the construction of a sewerage system and disposal works at the Sydenham Hospital, here. Estimated cost, $100,000.

KINGSTON — The Municipal Council plans to expend $30,000 for new purifiers, $10,000 for liners and $10,000 for generators to be installed in the gas plant.

OWEN SOUND—J. Legate, chairman of the Utilities Commission will soon award the contract for the construction of a concrete slow sand filter at No. 1 spring, Derby Township. Estimated cost, $35,000.

OWEN SOUND—The Utilities Commission is receiving bids for furnishing a slow sand filter. R. McDowell, engineer.

ST. CATHERINES—The city plans to build sanitary sewers and a sewage disposal plant. Estimated cost, $50,000. W. P. Near, City Hall, engineer.

Quebec

GRANBY—The Miner Rubber Co., 72 St. Peter St., has awarded the contract for the construction of a rubber factory to the Dominion Bridge Co., 285 Beaver Hall Hill, Montreal. Estimated cost, $35,000.

MONTREAL—The Scot-Canadian Magnesite Co., Ltd., Power Building, plans to build a plant on Shawinigan St. Estimated cost, $350,000.

VAL JALBERT—The Chicoutimi Paper & Pulp Co., Chicoutimi, is having plans prepared by L. Lamontagne, architect, Chicoutimi, for the construction of a factory. Estimated cost, $75,000.

Industrial Notes

ARTHUR D. LITTLE, INC., of Cambridge, Mass., has designed and is installing improvements and enlargements in the plant of the Minute Tapioca Co. at Orange, Mass.

THE NATIONAL REDUCTION Co. is building a large rosin and turpentine plant at Calvert, Ala., designed and erected by Arthur D. Little, Inc., of Cambridge, Mass.

THE NEW YORK TESTING LABORATORIES have been organized by Messrs. L. R. Seidell, G. B. Jack, Jr., and H. H. Geist, formerly chief metallurgist, assistant chief metallurgist and chief chemist respectively of the Wright-Martin Aircraft Corp. The laboratories are at 354 Mulberry St., Newark, N. J., and the New York office is established at 74-80 Washington St. In addition to chemical and physical testing and microphotography, this organization is specializing in the source inspection of materials, and as consultant in smelting foundry, drop-forging and heat-treating practices and the metallurgical investigation of shop troubles.

THE CARRIER ENGINEERING CORP., announces that Mr. E. P. Heckel has been made vice-president of the corporation and transferred from New York to Chicago as Western manager. Mr. A. E. Stacey, formerly Western manager, has been transferred to New York as head of the department of research and development.

BECKMAN & LINDEN CORP., San Francisco, Cal., has installed a 100-kw. single-phase electric furnace for commercial testing and research on the electric smelting possibilities of the Pacific Coast region.

THE METAL & THERMIT CORPORATION, New York, has recently completed the largest marine weld ever recorded, on the cast steel sternframe of the huge U. S. Army Transport Northern Pacific. The section welded was entirely broken through as a result of the severe strain to which the frame was subjected when this transport, laden with homeward-bound troops, ran aground on Jan. 2, 1919, in a dense fog, off Fire Island, New York. The weld required 1400 lb. of thermit for the chemical production of the necessary amount of molten steel, and was made without removing the casting from the ship.

THE CHEMICAL FOUNDATION, INC. has opened offices at 81 Fulton St., New York City and is ready to discuss the issuance of licenses for the various German chemical and metallurgical patents which it controls. Licensees must be all-American and possess ability and equipment to manufacture under the license.

Coming Meetings and Events

THE AMERICAN CERAMIC SOCIETY will hold a meeting in Chicago, Sept. 24.

THE AMERICAN CHEMICAL SOCIETY will hold its Fall meeting in Philadelphia, Pa., Sept. 2-6 inclusive.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its Fall meeting in Chicago, Sept. 23-25 inclusive.

THE AMERICAN ELECTRO-PLATERS' SOCIETY will hold its 1919 convention in Philadelphia, Pa., July 1-3.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1919 convention in Philadelphia, Sept. 29 to Oct. 4.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its Fall meeting in Chicago, Ill., Sept. 22-27.

THE AMERICAN STEEL TREATERS' SOCIETY will hold its first annual convention in Chicago, Ill., Sept. 22-27.

THE FIFTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in Chicago, Ill., Sept. 22-27 inclusive.

THE INSTITUTE OF METALS DIVISION of the A. I. M. E. will hold its next meeting in Philadelphia, Pa., Sept. 29 to Oct. 4.

THE INSTITUTE OF METALS will hold its Autumn meeting in Sheffield, England, Sept. 24-25.

THE INTERALLIED CHEMICAL CONFEDERATION will hold its next meeting in London, July 15-18, 1919.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its Fall meeting in Chicago from Sept. 24 to 27.

THE SOCIETY OF CHEMICAL INDUSTRY will hold its annual general meeting in London July 15-18, 1919.

Stocks and Bonds

Closing Bid and Asked Quotations June 26, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am.Ag.Ch.	108	109	Mat.Al.Wk.	31	40
do.pf.	99⅞	100	Ten. C. & C.	13½	13⅞
Barrett Co.	132	134	Un. Dyewood.	63	70
do.pf.	116½	117½	do. pf.	97	97¾
Gen.Chem.	185	199	Va.-Car. Ch.	82½	82¾
do.pf.	102½	108	do. pf.	114½	115
Int.Ag.Cb.	24⅞	26			
do. pf.	85	85½			

Bonds

Am. Ag. Ch., 1st cv. 5s, '28	98	99½
Am. Ag. Ch., cv. db. 5s, '24	106	114
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32	82¾	83
Va.-Car. Ch., 1 mtg. 5s, '23	97¾	98½
Va.-Car. Ch., cv. db. 6s, '24	101¾	102

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co.	91	93	P-A Pet & Tr.	93	93½
Cal. Pet.	34	34½	do. pf.	167	174
do. pf.	77	77½	Pierce Oil	23¼	23½
Col. G. & E.	58¾	59	Royal Dutch.	111¾	112
Mex. Pet.	183¾	184	Sinclair O & R	61	61½
do. pf.	107	108	Texas Co.	268	269
Ohio Cit. Gas.	56½	56¾	Tex. Pac. Ld. Tr.	400	500
do. pf.	..	..	Tidewater Oil.	237	240
Ohio Fuel S.	50	50½			
Okla. P. & R.	10½	10¾			

Bonds

Columbia Gas & Electric, 1 5s, '27	88	90
Col. G. & El., std. 1 5s, '27	88	
Pan-Am. Pet. & Tr. 1 6s, '19-'27	140	....
Pierce Oil, cv. db. 6s, '20	115	130
Pierce Oil, cv. 5% Notes, '24	106	106½
Sin. O. & R. 1 In. 7s, '20, with stk. war.	....	150
Sin. O. & R. 1 In. 7s, '20 without stk. war.	99½	99¾
Texas Co., db. 6s, '31	102½	103
Union Oil of Cal. 1 5s, '31	93¾	94½
United Fuel Gas 1 mtg. 6s, ser. A, '36	94½	97

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F.	42	42½	Pitts. Ste. pf.	96½	98
Beth. Steel	86½	87½	Rep. Iron &		
do. class B.	86½	87½	Steel	89½	90
do. pf., 8%	111¾	112½	do. pf.	103½	104½
do. pf., 7%	95	105	Sloss Sheff. I.		
Central Fdry.	21½	22	& S.	70½	70¾
do. pf.	47½	49	do. pf.	93	95
Col. F. & I.	46½	47½	Superior Steel.	43½	44
do. pf.	105	125	do. 1 pf.	102	110
Cruc. Steel	91½	91¾	Trans. & W.		
do. pf.	100	100¾	Steel	54	56
Great No. Ore	45	45½	Un. Alloy St.	51½	52
Gulf Sta. Steel	66½	67	U.S.C.I.P.&F.	35½	35¾
do. 1 pf.	94½	98	do. pf.	63¾	64½
Lack. Steel	82½	83½	U. S. Steel	107½	107¾
Mid.St.& Ord.	51	51¾	do. pf.	115	115½
Nova Scotia			Va. Coal, I&C.	64	67
Steel	81	83			

Bonds

Beth. Steel, 1 ext. gtd. S.F. 5s, '26	96½	96¾
Beth. Steel, 1 In. ref. 5s, Ser. A, '42	92	92½
Beth. Steel, P. M. & I. S. F. 5s, '36	88	88½
Buff. & Susq. Iron, 1 S. F. 5s, '32	92	96
Buff & Susq. Iron, deb. 5s, '32	...	...
Cent. Found. 1 mtg. S. F. 6s, '21	80	83
Col. F. & I., gn. S. F. 5s, '43	90	92
Ill. Steel, db. 4½s, '40	85½	86
Ind. Steel, 1 mtg. gtd. 5s, '52	96	96½
Lack. Steel, 1 5s, '23	97	98
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	93	95
Mid. St. & Ord., clt. cv. S. F. 5s, '36	89¾	90½
Nat. Tube, 1 mtg. gtd. 5s, '52	98½	99
Rep. I. & S., S. F. mtg. 5s, '40	94½	95
Tenn. C. & I. R.R., gn. 5s, '51	93	94
U. S. Steel, S. F. 5s, '63	100½	101
Va. C., I. & C., 1 5s, '49	86	88½

Published SEMI-MONTHLY *on the* FIRST *and* FIFTEENTH *of each month*

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, July 15, 1919 *Number* 2

The Season of Tariff Hearings

ELSEWHERE in this issue we report some of the hearings recently held in Washington before the Ways and Means Committee of the House of Representatives on bills designed to derive revenue for the Government and encourage the domestic producton of certain minerals and mineral products. In other words, a new tariff is about to be framed, and proponents of tariff protection for certain industries have been active in presenting their claims. Tungsten, magnesite, potash, zinc, dyes, optical glass, chemical glass and laboratory apparatus are among the items for which protective duties are asked. The reasons are various, ranging from the protection of key industries to the loyal support of domestic enterprises that will free us from German domination. In the main they are all good.

A reading of the arguments is suggestive of the delicate problems that Congress will be called upon to solve. Shall we protect one industry when the effect will be to levy tribute on several others that would thrive better under free trade? On the one hand we have the infant industry, in this case possibly a war industry, clamoring for protection and urging deliverance from foreign, possibly German, bondage. On the other hand, we find consumers who prefer a foreign product for real or fancied superiority and who object to being taxed to support a domestic industry. Truly the wisdom of a Solomon is demanded. For our own part we have previously expressed an opinion to the effect that industries asking tariff protection must be on a sound economic basis, with good business direction and technical control. We cannot look with favor on substituting a tariff for industrial inferiority or lack of technical skill; nor, on the other hand, do we believe that a little foreign competition will be harmful. In this respect we like the attitude of the tungsten producers, who say frankly that the duty they ask will still permit foreign ore to enter to the extent of half our domestic needs, while it will also act as a stabilizer of the industry at home.

In the case of scientific glassware and apparatus we confess to an abhorrence of the duty-free favor granted our colleges and universities, because it has made German products better known than American; and for the further reason that continuance of the plan affords an entering wedge for German propaganda among our students. On only two occasions, after the Mexican and Civil wars, have our revenue requirements been such as to make it necessary to exact duty from the beggarly funds of our colleges. Today the question is quite different. Freight charges on this class of material are small compared to values. Eighty to 90 per cent of the cost of production is for labor, and the low-wage countries will find these industries peculiarly their own. In Germany there are over 500 firms manufacturing scientific apparatus, employing thousands of instrument makers and technical men. Less than one-tenth this number is credited to the United States even after four years of favorable development. We cannot look with favor on the subordination of these industries at home merely to favor the colleges. We believe our educational institutions want to stand on their own feet and pay their way. We believe that students and faculty alike will scorn the savings that might be effected by taking the sop thrown by foreign competitors. Sixty per cent duty may be needed, and domestic goods may cost our colleges $2,000,000 additional each year, but this may be regarded as insurance against pitiful dependence on an undesirable neighbor.

A New Philosophy Of Chemistry and Matter

ELSEWHERE we print in this issue Mr. HENDRICK'S paper on the Langmuir postulates, which is designed as an introduction to the subject and not as a complete exposition of it. The changes proposed in regard to the conception of molecules and valence are so radically different from those with which we are familiar that it is hard to forego the natural disposition to oppose them. It requires an easy familiarity to make use of the postulates in thinking of chemical reactions and the resultant bodies, and we believe that in time it will be possible to approach them with greater clarity than at present. The series which we present contains but eight, whereas in Dr. LANGMUIR'S original paper there were eleven. In his later papers they will appear in the present form—for which we are indebted to him—and we hope that this, too, will be simplified as time goes on.

The promise, as indicated in the amazing similarities of physical qualities between bodies apparently unrelated except that they are held to be identical in their atomic or molecular structures, is too great to be passed over without careful observation and scrutiny. If by applying the octet rule and determining the covalence of each atom we may determine the physical nature of a body even before it is synthesized, we have, without doubt, an instrument of great value in chemical practice. But it may even be determined, according to Dr. LANGMUIR'S theories, whether unknown substances will have color or not. Again, it has always wrenched us to consider that, among metallic salts, for instance, no molecules are formed, but that they build a lattice of alternate positive and negative ions which are held together by electrostatic force rather than by bonds. Nevertheless this conclusion, which is wholly in accord with the work of the BRAGGS, now appears reasonable, except in the shade of prejudice; and in the end we seem to obtain from it a remarkably practical working concept of chemical processes. It is, however, unfamiliar—and it is a normal human reaction to deny that which is unfamiliar.

Our colleague the ever urbane editor of *Scientific Monthly* evidently feels that way. After listening to a presentation of the subject by its author during the Convocation Week of the American Association for the Advancement of Science, in Washington, he says, referring to the addresses of Professor BREASTED of Chicago and DR. LANGMUIR of Schenectady, that they (the addresses) "might lead to the inquiry why a student of Mexican archæology is eligible to membership in the [National] Academy but not a student of Egyptian archæology," and "why a metaphysician who calls himself a chemist is eligible, but not one who calls himself a student of philosophy."

As the author of our paper intimates, Dr. LANGMUIR is almost resentful of metaphysics in connection with comprehensible and concrete facts. He does deduce the rule that electrons tend to gather in pairs and octets about positive charges, but if this be metaphysics then so is valence, and so also is the law of definite proportions.

WERNER'S theory of secondary valence, while not wholly in accord with the Langmuir postulates, is illuminated by the octet rule. WERNER'S observations are confirmed, but they are explained by a different method. Neither this feature, however, nor several others of marked importance, are touched upon in our present article. Our immediate business is of an introductory nature.

Are We Engineers or Are We Economists?

A SPECTACLE of high wages together with a surplus of labor, high commodity prices together with a small turnover, extreme spread between wholesale and retail prices and yet moderate purchasing by the ultimate consumer, cold storage and granaries bursting with foodstuffs yet meat and dairy products beyond the reach of ordinary purses—this spectacle certainly holds puzzling inconsistencies to the thoughtful observer. The times are so badly out of joint that his personal experience cannot bridge the gap, and yet he is confronted with the insistent question: "What can I do about it?"

What is to be done? Economists who hold the front of the stage assure us that nothing can be done except grin and bear it; make up your mind to buy what you need and pay the price, say they. "Opportunity is here!" shouts the publicist. "The shelves of the world are bare." True, indeed, but has poor Mother HUBBARD a bare purse as well as a hungry dog?

Students of economic life make much of the so-called law of supply and demand, and its many adaptations. Thus—we have recently seen an enormous inflation in currency and credit, the actual amount of usable goods has probably decreased, prices therefore have gone up with the volume of money available. This really seems a good definition of high prices rather than an explanation of how they came about—in other words, the fact that we have a huge gold reserve is not the immediate reason an Oregon horticulturist asks and gets 13 cents for prunes he gladly sold for 5 a few short years ago. On the face of it there seems to be a human as well as a material element in prices. We are inclined to think—not being economists, merely engineers—that some influential economists have overlooked a profound determining factor in price levels, and this factor is that a price is determined not only by the available supply of needed goods and the total amount of purchasing power in existence, but also in large measure by how badly the individual purchaser thinks he needs and desires the thing, the availability of acceptable substitutes, and the credit or money he actually possesses. When butter goes beyond a certain price, he doesn't buy as much as he needs.

Thus one arrives at the psychological factor, at once ignored and acknowledged by publicists—ignored in arguing for permanence of high prices; acknowledged in their campaign to create a "purchasing state-of-mind." Some even go so far as to print in black headlines "All Price Revisions Will Be Upward!" As a general, long-time trend, yes; as an immediate tendency, by no means! Do they mean that the glaring inefficiency of management, labor and process which was so shamelessly condoned during war time cannot be improved? Do they mean that the exorbitant capital profits, amounting in many cases to the total pre-war cost of the commodity, cannot be eliminated? Do they mean that $12 shall be maintained as a price for a shoe costing $6 simply because the raw material, manufacture and sale are so closely controlled that the higher price can be demanded?

Historical economists are fond of pointing out the rise in commodities which accompanied and immediately followed the four recent wars in justification of their stand that the present price levels will be permanent. Perhaps the analogy is correct. But they fail to add a note explaining the drop in commodities which actually occurred sooner or later. Apparently if it be true that high prices are due to inflation, and inflation is due to the waste of war, it certainly follows that high prices can be cut by reducing waste. Here, indeed, is where the engineer can help—at least he can be of vital force instead of an apologist. The human element is again overlooked when no mention is made of the reason—cited solely as an instance—why pig iron should drop from $53 just after the Franco-Prussian war to $9 just before the Spanish-American war. That was technology! Not only bigger blast-furnaces, but better chemistry and metallurgy, better transportation, better electrical and mechanical engineering, and the application of iron and steel to thousands of everyday uses!

Enough has been said to indicate the extreme complexity of the economic situation. Economic laws are not deducible to mathematical formulæ as are those of gravitation, because the human element—that most complex of variables—enters. Engineers are treading on *terra incognita* and are in danger of being bogged when they make pronouncements based on economics; far better it would be to insist at all times and places upon the extreme desirability of reducing costs by scientific technological management. Here we can speak with authority, candidly acknowledging in all our dealings the close relationship between the human and the material, the worker and the machine.

Reduce waste, perfect processes, increase efficiency of men and machines, lower costs by increasing the volume of production, raise the standard of living by making it possible for the common citizen to purchase good products, and engineers can then rest assured that their work has been well done, since it has vastly increased the sum total of human happiness. That is really the end of it all!

A Phase of the Flotation Decision

IN OUR digest of the Supreme Court's decision in the case of Minerals Separation vs. Butte & Superior, we doubt if we emphasized sufficiently those words of the Court's opinion in which it defines the scope of Minerals Separation's right as "limited to the means they have devised and described as constituting the process." Granting the plaintiff its right to the process when oil is used in a fraction of one per cent on the ore, the Court nevertheless holds that the patentees discovered the *process* and not the *result*, and limits the process to the *means* disclosed. Evidently if the same result can be attained by some other means, the industry still has the prospect of working with an economical use of oil. In our judgment the bubble-column process, commonly spoken of as the pneumatic-cell process, is outside the means disclosed by Minerals Separation in patent 835,120 and is therefore open to use with an economical quantity of oil, and without infringement of the patent referred to. This may have a profound influence on future flotation practice.

The Determination Of Steel Prices

THE steel market has for many years presented an interesting psychological study. There has been some evidence of the working of the much mentioned law of supply and demand, but after all the steel market has been made more by psychological than by physical influences. It has been a matter not only of how the minds of producers react to certain influences but also of how the minds of buyers react.

In most of the steel price advancing movements of the past fifteen years the co-operation of buyers has been necessary. It was a case of one advance bringing on another. The buyer, seeing the market exhibiting strength by advancing, would place contracts for forward delivery for additional tonnages and when this buying had encouraged the mills to make another advance the buyer would buy again, thus furnishing the basis whereby prices could be advanced upon him a third time, and so on.

As to the sellers, the mental attitude has influenced conduct, though not always in the same way. In the decade of the 1890's, when the mild-steel business was young as the successor to the wrought-iron business, the mental attitude of the producer was frequently not so much that of endeavoring to secure orders as of preventing his competitor from securing them. It was a common practice to induce a consumer to place a contract for material he did not expect to need, with the idea that he might possibly find occasion to use the material, and then the seller who had seen him first would receive the specifications. The fundamental principle was that of undermining the competitor's business rather than of building up one's own business. The pools and associations that throve on paper were patronized by producers not so much because they individually expected to adhere to the agreements as because hopes were entertained that others would do so, and thus lose orders.

Subsequently the psychology of producers changed. Passing over a few years, first of the existence of the combinations preceding the Steel Corporation and then the earliest years of the Steel Corporation itself, there began a period in which the idea of domination was definitely and actively renounced. The larger of the individual manufacturers in the early years of steelmaking sought domination as the only safe position. The Steel Corporation, on the contrary, recognized that in the long run domination would be suicidal because neither the law nor the public would give it countenance. Markets, however, must be made through the operation of one influence or another. They do not spring from nothing. Markets are made by men, and the question is only as to the influences to which men allow their minds to react. The influence may be the relation between the tonnage that is likely to be consumed and the tonnage that can be produced, or the mental attitude of buyers, or the mental attitude the producer believes his competitors occupy.

The Great War sent steel prices to undreamed-of levels, and then Government control intervened. At the close of the war demand dropped to small proportions. Here was an upheaval or succession of upheavals which one would naturally expect to leave the market in a highly unsettled state, capable of wide fluctuations. A practical question is whether, after so great a disturbance, steel prices are going to fluctuate more or less during the next half dozen years than they did in the decade before the war. After such a disturbance wider fluctuations than usual might reasonably be expected, but having in mind the psychological influences at work one might conclude that the clearly apparent danger of a widely fluctuating market would induce the men who make the markets, irrespective of whether their decisions are individual or collective, to take special pains to prevent such wide fluctuations in prices.

Much has occurred that is suggestive of the possibility that eventually the Federal Government will be largely instrumental in the formulation of steel-market prices. The Federal Trade Commission was organized in March, 1915, and has had more or less to say about steel prices, particularly during the war. The Supreme Court is to decide the Government's dissolution suit against the Steel Corporation, which gives that branch of the Government a vital interest in the subject. It will, in a measure, pass upon the propriety of the steel prices that have obtained during a large part of the Steel Corporation's life, from the viewpoint of the public interest. Last February the Department of Commerce formed the Industrial Board for the purpose of deflating or stabilizing steel prices, and while the Industrial Board had rather an ill-starred and brief career the fact is not modified that there was a desire in Washington that such an organization should exist and function.

Even nearer to the point is the fact that when the organized steel consumers of the Chicago district recently urged that Chicago be established as a separate basing point for steel products, thus reducing the previously universal scope of the Pittsburgh basis, the steel producers proposed that the matter be laid before the Federal Trade Commission. If it is proper that the Commission should decide what prices should obtain in the Chicago district relative to Pittsburgh basis prices, it is no great step for it to have a voice in determining what prices should obtain at Pittsburgh relative to industrial conditions.

Readers' Views and Comments

Fusibility of Ash From Pennsylvania Coals

To the Editor of Chemical & Metallurgical Engineering

SIR: I have read with much interest the paper on "Fusibility of Ash From Pennsylvania Coals," which appeared in your issue of June 15, 1919. Messrs. Selvig and Fieldner make one statement in that paper which I feel should not pass without some comment and qualification. The last paragraph on page 629 reads:

"The ash from the anthracite region of Pennsylvania is very refractory, coming in Class I. The softening temperature in practically every instance is above 3000 deg. F."

Now this statement is true in so far as it covers the ashes of coals tested and reported in the paper by Selvig and Fieldner, but the fact remains that ashes from certain anthracite coals have not been included in the published results. In order that the statement made by the authors may not mislead any one into regarding all anthracite coal ash as highly refractory, it has been thought desirable to submit some data on work done in this laboratory.

In a paper on "Chemistry in Coal Mining," published in the Aug. 19, 1916, issue of *Coal Age*, a table was given showing fusing temperatures and analyses of ashes of coals from different mines. The content of alkalies in the ashes was not determined, and any titanium dioxide was included in the percentage of aluminum oxide. The data are given in Table I.

This table shows that the ash of some anthracite coals fused between 2210 and 2282 deg. F., whereas the ash from other anthracite coals did not fuse at a temperature of 2570 deg. F., this temperature being the highest reached in the tests made at that time.

Later work in which higher temperatures were reached has shown practically the same results. The ashes from Shamokin, Locust Mountain and Hard White Ash coals have, in general, shown high fusing temperatures, mostly above 2600 deg. F. The ashes from Lorberry coals have shown somewhat lower fusing temperatures. The ashes from Lykens Valley coals have shown very much lower fusing temperatures, some such ashes fusing even below 2282 deg. F.

This lower fusing temperature seems to be coincident with relatively higher content of calcium oxide and sulphuric anhydride in the ash of the coal. The sulphur content of the coal itself, in the case of Lykens Valley coals, is very low, but much of this sulphur is left in the ash after burning, possibly in the form of calcium sulphate. Further work on this problem is highly desirable.

It might be remarked, in passing, that while the ash from Lykens Valley coal has a low fusing temperature, yet the ash from bony coal or slate has a fusing temperature above 2600 deg. F.

Unfortunately, our tests on coal ashes were made in a rather crude way. The ashes, molded into form of small cones, were heated in a muffle furnace over a coke fire, the temperature being determined by comparison with Seger pyrometric cones. The atmosphere, if we may judge from the appearance or color of the ash cones, was an oxidizing one.

We do think, however, that our work is of considerable value, at least from a comparative standpoint, and we submit the above statements as information modifying some of the conclusions reached by Selvig and Fieldner.

A. G. **BLAKELEY.**

Philadelphia & Reading Coal & Iron Co.,
Pottsville, Pa.

Tin in Bolivia

To the Editor of Chemical & Metallurgical Engineering

SIR:—A study of the tin deposits in the world shows that Bolivia occupied a very prominent position, not only on account of the nature of the minerals found in its mountains, but also because of the wealth of its ore deposits. If we consider the various sources of tin, we find the most important to be as follows: The peninsula of Malacca, Banka, Billiton, Sumatra, Siam, New South Wales, Australia, Tasmania, New Zealand, Cornwall, Transvaal, Japan, Finland, China, Korea, Siberia. Other deposits of less importance in central Europe are in Spain, Portugal, France, Italy, Scotland, Ireland and the well-known deposits in Bohemia; some in the United States and Alaska; and none in South America except in Bolivia, which has gradually become second in importance as a producer of tin.

Nevertheless the tin deposits of Bolivia are very little known and up to date only a comparatively small section has been exploited, and that is the region which is richest and possesses minerals of the most desirable composition. In a word, it can be said that the only mines operated in Bolivia are those which contain extraordinary wealth. In the meantime in my opinion the real future of Bolivian tin industry lies in those deposits of lower grade which up to the present time have not been touched.

The country contains extensive deposits of tin in the principal mountain chains; and in some of the rivers

TABLE I.

Colliery	Fusing Temperature, Deg. F.	Silica, SiO_2 Per Cent	Alumina, Al_2O_3 Per Cent	Iron Oxide, Fe_2O_3, Per Cent	Calcium Oxide, CaO, Per Cent	Magnesium Oxide, MgO, Per Cent	Sulphuric Anhydride, SO_3, Per Cent	Phosphoric Anhydride, P_2O_5, Per Cent
No. 13	2210–2282	54.54	26.68	11.67	3.36	1.20	2.22	trace
No. 14	2210–2282	52.38	30.68	9.94	2.10	1.00	2.59	0.56
No. 15	2282–2390	55.43	26.81	9.14	3.76	1.85	1.52	0.48
No. 16	2282	56.35	29.91	9.54	0.98	1.10	0.51	0.40
No. 17	2462–2498	56.50	28.17	9.44	1.40	0.85	2.17	0.59
No. 18	2534	52.83	24.48	15.50	2.38	1.65	1.39	0.45
No. 19	Above 2534	55.78	30.91	10.64	0.45	0.50	0.10	0.23
No. 20	Above 2534	51.44	34.47	9.44	1.96	0.68	1.02	0.63
No. 21	Above 2534	55.84	32.79	7.55	0.71	1.10	1.15	0.39
No. 22	Above 2570	52.00	33.71	8.89	1.92	0.59	1.17	0.28
No. 23	Above 2570	54.28	31.22	11.67	1.21	0.44	0.69	0.24
No. 24	Above 2570	50.60	33.99	11.93	0.81	1.03	0.86	0.46
No. 25	Above 2570	52.94	37.66	7.22	0.56	0.55	0.69	0.27

which rise in some of these mountains there are large alluvial deposits of tin which have never been exploited. In order to produce the metal in large quantities at a profit it would be necessary only to install large concentrating plants that would handle thousands of tons per day. To accomplish this it would be necessary first to interest American capitalists to make a study of the country and invest in Bolivia the large capital that would be required to make these installations.

I have always been surprised at the fact that the United States, itself the largest consumer of tin in the world, has never made the slightest effort to own its mines; and it is quite surprising that the United States has never taken notice of Bolivia, the country richest in this mineral, where it would be possible to make a development sufficiently extraordinary to supply the total consumption of North America.

Recently Mr. William S. Kies, vice-president of the American International Corporation of New York, visited Bolivia. I have had the pleasure of several talks with him on the subject of tin production and have called his attention to the fact that his country should make a study of Bolivia from the point of view of developing tin mines on a large scale. I trust that this may serve as a starting point for a business development that will be of mutual benefit to both nations.

La Paz, Bolivia. JUAN M. REYES.

Copper in Slags

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the review of our article on Slags published in the last issue of your journal, there is a numerical error in the first column. You say that analyses of blast-furnace and reverberatory slags showed an average residue of 0.7 per cent Cu insoluble in $AgNO_3$, with an average deviation of only 0.11 per cent.

The figures should be 0.147 per cent instead of 0.7 per cent, and the average deviation should be 0.011 per cent. G. D. VANARSDALE.

Phelps-Dodge Corp.,
New York City.

The Analysis of Red Lead

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the above heading in your issue of March 15, I have looked up the article published in the *Journal of Industrial and Engineering Chemistry* of March, 1916, and find that Mr. Schaeffer, in his application to the analysis of red lead, failed to give me credit for a prior application of the lead peroxide-hydrogen peroxide-potassium permanganate reactions in dilute nitric acid solution for determining lead (Ericson's lead method), although I have published several papers on the subject, viz.:

> "A New Volumetric Method for the Determination of Lead," *Journal of the American Chemical Society*, September, 1904.
>
> Later another paper on its application to spelter analysis entitled "A New Technical Method of Spelter Analysis" published in the *Journal of Industrial and Engineering Chemistry*, May, 1913. Other papers were published in the *Engineering and Mining Journal* at various times.

I have used this method daily (peroxidizing the lead by means of ammonium persulphate in ammoniacal solution, filtering, dissolving in a known excess of hydrogen peroxide solution, and titrating the excess by standard potassium permanganate) for a dozen years in the zinc industry and on Joplin ores principally, so it is strange that Mr. Schaeffer should not have heard about it. Several Joplin chemists have been acquainted with it, and some in the lead industry.

Mr. Schaeffer deserves credit for his ingenious application of my method to the analysis of red lead, but should have given me due credit.

ERIC JOHN ERICSON.

Philadelphia Meeting of the American Chemical Society

THE annual meeting of the American Chemical Society will be held at the Bellevue-Stratford Hotel, Philadelphia, Sept. 2 to 6, 1919. Unusual interest will center in this meeting on account of the consideration of important problems confronting the chemical industry. The adaptation to peace purposes of plants erected primarily for the production of explosives and munitions will be one of the important subjects under discussion. In this connection the Hon. Newton D. Baker, Secretary of War, has promised to make an address at the general meeting.

The division of industrial chemists and chemical engineering will have a symposium on refractories which will interest all who are concerned with furnace linings and processes where heat-resistance is required. Another subject to be considered by this division is the revision of the patent law, with particular reference to the charge of a renewal fee to prevent so-called patent pirates from keeping claims on file indefinitely with no intention of developing the patent. A representative of the Patent Office is expected to be present and an invitation has also been sent to A. Mitchell Palmer, Attorney-General, formerly Alien Property Custodian.

The newly constituted rubber section is expected to have a program of considerable interest.

The Philadelphia section is making arrangements for entertainment of visitors, and it is expected that all of the large chemical plants in Philadelphia and vicinity will be open. A boat trip on the Delaware has been arranged, and a visit will be made to the Hog Island Shipyard and the League Island Navy Yard. An automobile trip to Valley Forge and a smoker will be features of the entertainment.

The Philadelphia local section urges all who are able to attend the meeting to reserve hotel accommodations as soon as possible.

American Steel Treaters' Society to Hold Convention

In planning the first annual convention, to be held at the 7th Regiment Armory in Chicago from Sept. 22 to 27, inclusive, the American Steel Treaters' Society has decided to include an exhibit of freaks which have resulted from heat treatment. The members have been asked to contribute examples of tools that have, in hardening or tempering, acted contrary to all theory and ordinary practice or that have cracked, expanded, contracted, warped, etc., in an inexplicable manner. Other odd occurrences in heat treating iron and ferrous alloys will be shown. It is hoped that the interest aroused in this exhibit will result in an exchange of explanations and theories which will aid materially in increasing our understanding of the mechanism of heat treating.

Tariff Hearings on Tungsten

THE proposed tariff on tungsten ores and products as embodied in the Timberlake bill (H. R. 4437) was the subject of hearings before the Committee on Ways and Means, House of Representatives, June 13, 14 and 17, 1919. The bill provides for duties on crude tungsten ores and concentrates of $10 per unit WO_3, and on metallic tungsten, ferrotungsten, tungstic acid, salts of tungsten, tungsten steel and other tungsten products of $1 per lb. of tungsten contained therein. The purpose of the tariff is to stabilize the tungsten industry in this country and to prevent the dumping of foreign tungsten ore from countries where cheap labor prevails.

It was brought out that the domestic requirements for the next few years may be estimated conservatively at 5000 to 7500 tons of 60 per cent concentrates per year. Domestic production has provided about 60 per cent of our needs, the balance being imported. One witness was of the opinion that the proposed duty would still allow 50 per cent of the tungsten used in the United States to be imported. He stated that it was not contemplated that foreign ore would be shut out.

Evidence was introduced to show that Asiatic ore could be delivered in this country at $7 per unit and still afford the Asiatic miner a profit. Labor costs for coolies were reported as 40 to 47c. per day for men and 20 to 27c for women and children. Ore from Bolivia, however, during the war was delivered at New York for between $20 and $22 per unit, though probably it could now be delivered at $16 to $18 a unit. The cost of producing tungsten in the United States is impossible to estimate with accuracy. It may be great or small, varying with the ore body and the cost of development. As a consequence costs are so widely different that any attempt to correlate them is fruitless. In Colorado in 1918 costs were estimated to range from $15 to $33 per unit, with an average of approximately $20. California costs are lower, but the U. S. Tariff Commission estimates that one-half of the domestic output is produced at a cost from $10 to $15 per unit and that the remainder costs from $15 to $25 per unit, averaging, say, $20.

The status of the tungsten industry in the United States is one of complete inactivity if we except operation of one mine in Nevada. Since the declaration of armistice all other properties have been closed. The Colorado producers showed that some properties were dismantled and that millions of dollars worth of property was affording no return on the investment. Cost of producing in this district has been increasing with the depth of the mines and the reduced grade of the ore. At the outbreak of the war the price of tungsten ranged from $6 to $7 per unit and the industry was paralyzed. War demand caused prices to soar as high as $90 per unit early in 1916. Later the price fell off to $20 or $25 per unit. When the price fell to $17 per unit all of the mines closed. This figure therefore was considered the dead line for all except a very few American producers, and it was the opinion of one witness that the figure represented absolute minimum cost of production.

Witnesses expressed their belief that a duty of $10 per unit on tungsten ores and concentrates would enable domestic producers to develop tungsten resources so that national requirements could be met at any time. It was felt also that $10 per unit would practically cover the difference between the average cost of production in the United States and foreign fields. It was very clearly brought out that *ad valorem* duties were inapplicable to tungsten ores because they were simply an invitation to foreign exporters to declare a low valuation and thereby pay a low duty.

Zinc Ores and the Tariff

THE Joplin district zinc ore producers were represented before the House Committee on Ways and Means at a hearing held June 18, 1919. Paul A. Ewert, Otto Ruhl and E. B. Howard, Representative from Oklahoma, submitted testimony and exhibits to support the contention of the zinc-ore producers that a specific import duty of 2c. per lb. of zinc in ores containing over 25 per cent zinc was necessary to maintain the zinc mining industry in the Joplin district. The importation from Mexico of ores that were produced at a low cost, due to cheap labor, has practically closed the zinc mines in Missouri and Oklahoma.

The average cost of producing 60 per cent concentrates in the Joplin district during the first part of 1919 has been between $45 and $55 per ton, depending upon local conditions, whereas the average declared valuation of Mexican 30 per cent ore for the first three months of this year was $9.42. The cost of producing 1 lb. of zinc in Joplin concentrates is therefore about 37c. and from Mexican ore 1.5c. The producers therefore reason that the 2c. per lb. specific duty is justified.

The larger quantities imported during the war period came from Australia, Canada and Mexico. Table I shows the amounts. Table II shows the declared value of imported ore per ton compared with the average base price of Joplin zinc ore for same periods.

TABLE I. ZINC CONTENT OF IMPORTED ORE

	1914	1915	1916	1917	1918
Australia	....	11,130	56,726	23,237	789
Canada	4,345	4,040	8,092	5,540	6,300
Mexico	2,895	15,365	34,805	54,154	28,671

TABLE II—DECLARED VALUE IMPORTED ORE PER TON COMPARED WITH AVERAGE BASE PRICE JOPLIN ZINC ORE FOR SAME PERIODS

Year Ending June 30	Long Tons (2,240 Lb.)	Value	Value, Short Tons[1]	Value Joplin Zinc Ore
1914	18,280	$13.70	$12.23	$39.79
1915	79,814	22.77	20.33	54.16
1916	291,264	32.32	28.77	92.78
1917	262,767	28.57	25.50	73.57
1918	102,234	24.44	21.82	58.30

[1] Values of short tons of 2,000 lb. are computed in order to compare with Joplin ores, given in short tons.

All imported ore has been subject to a 10 per cent *ad valorem* duty. It was brought out in the hearing that the value to which the *ad valorem* duty is applied was furnished by the exporter and represented his valuation of the ore for export and at the port of shipment. There has been a large difference in the actual valuation at port of entry and this figure. It was brought out that in the case of Germany before the war there were two valuations of zinc ore—one for home consumption and the other for export.

The method adopted by the Treasury Department for ascertaining the value of zinc in imported ore arriving in the United States is as follows:

(1) From the ascertained assay deduct 8 units for sulphide and 6 units for non-sulphide ores. The re-

mainder will represent percentage of recoverable zinc in the ore, which multiplied by 2000 will give the number of pounds of zinc recoverable from a ton of ore.

(2) Multiply the result as above ascertained by the average price of prime Western spelter at East St. Louis for the week in which the ore was exported; that is, the week including the date of sailing of the ship or day the car leaves the foreign country. This will give the gross value of the zinc in the ore at the time of its exportation.

(3) Deduct from the gross value of the zinc in the ore as above ascertained the following:

(*a*) The freight actually paid from the foreign mine to the domestic smelter receiving same in the U. S.

(*b*) The insurance actually paid.

(*c*) The actual shipping charges.

(*d*) Foreign export duties and charges, if any.

(*e*) Treatment charge (as explained in par. 4).

(*f*) Penalties for iron (as stipulated in par. 5).

(*g*) Duty on lead contents, if any.

(*h*) Duty on zinc.

(4) *Treatment charge.* (*a*) For sulphide ores the treatment charge will be ascertained as follows: From the value of the recoverable spelter in a ton of 2000 lb. medium grade Joplin sulphide ore, 60 per cent base, deduct the average of the quoted prices for such ore and $1.50 per ton of 2000 lb. as representing the average freight on Joplin ores from Joplin, Mo., to common Kansas smelting points.

(*b*) For non-sulphide ores the treatment charge will be ascertained as follows: From the value of the recoverable spelter in a ton of 2000 lb. of 40 per cent calamine ore deduct the average of the quoted prices for such ore and $1.50 per ton of 2000 lb. as representing the average freight paid from Joplin, Mo., to common Kansas smelting points.

(5) *Penalties.* On iron ore deduct penalties as follows: $1 on each unit of iron in excess of 1 per cent up to and including 6 per cent; $0.50 per unit on each unit of iron in excess of 6 per cent up to and including 12 per cent; $0.25 for each unit of iron in excess of 12 per cent.

(6) The average market price of Joplin zinc ore and prime Western spelter to be taken in accordance with quotations contained in the *Engineering and Mining Journal* for the calendar week including the date of the sailing of the ship or day the car leaves the foreign country.

(7) Recoverable spelter, wherever that term is used in this memorandum, means for sulphide ores the assay minus eight units, and for non-sulphide ores the assay minus six units.

Congressional Hearings on Patent Office Bills

The House Committee on Patents began public hearings on July 9 on three bills relating to the Patent Office. One of these bills proposes to establish a United States Court of Appeals. The second bill would reorganize the Patent Office, remove it from the control of the Department of the Interior, and create an independent bureau to be known as the Patent and Trade Mark Office. The third measure proposes to revise the salaries and create additional department heads in the patent service. All three measures are fostered by the National Research Council.

One of the first to testify before the committee, of which Representative Nolan is chairman, was Fred T. Fish of Boston, a patent attorney, who urged the separation of the Patent Office from the Department of the Interior. Many other patent attorneys and experts are expected to present arguments to the committee, and the presentation of arguments has been placed in the hands of Mr. Prindell, secretary of the National Research Counsil.

It is understood that the committee is willing to hear anyone interested, and that it reserves to itself the right to amend the bills which were drawn by the National Research Council.

War Trade Board Transferred to State Department

Pursuant to an executive order signed by the President on May 12, 1919, the present personnel, duties, powers, functions and records of the War Trade Board have been transferred to the Department of State as of July 1, 1919.

This transfer will not affect or inconvenience the exporting and importing public in any way. The functions of the War Trade Board will continue to be performed by the present personnel in the building at Twentieth and C Streets, Washington, D. C.

All licenses will continue to be issued in the name of the War Trade Board, and all applications for licenses, and all correspondence pertaining to the activities of the War Trade Board, now assumed by the Department of State, should be addressed to the War Trade Board as heretofore.

The War Trade Board Section of the Department of State announces that it will issue licenses permitting the importation, on or after Sept. 1, 1919, of pig tin and all metal alloys containing tin, including tin drosses, tin oxides, solder drosses, type metals, antifriction metals, waste metals, and other metals containing tin, from points other than points of origin and without reference to the date of shipment.

Columbia University Fellowships

The General Bakelite Co. has provided the funds for an industrial fellowship in the department of chemical engineering of Columbia University. This fellowship differs from the general type of industrial fellowships in that, in addition to the amounts paid to the fellow and for the chemicals and apparatus used by the fellow, a sum is paid to the university to compensate it for the use of the laboratories and other facilities used by the worker. A further difference is that no time or other limitation is put upon the publication of the results of the investigation. Mr. Mortimer Harvey has been appointed to this fellowship for 1919-20.

Mr. George Barsky has been appointed to the Bridgham fellowship ($1500) at Columbia University for the year 1919-20. He will work in the department of chemical engineering with Prof. McKee on the utilization of the waste liquor from sulphite pulp mills. Mr. Barsky received the degree of Chemical Engineer in 1918 from Columbia University.

Investigating Water Resources in Canada.—The Canadian Government decided in Council held on April 19, 1919, to investigate and develop the water-power resources of the Dominion.

Quicksilver Produced in the U. S. in First Quarter of 1919

According to figures compiled by F. L. Ransome of the United States Geological Survey, about 5960 flasks of quicksilver of 75 lb. net was produced in the United States from Jan. 1 to March 31, 1919. Returns from 23 productive mines gave a total of 5924 flasks, and it is estimated that 36 flasks was obtained from two or three small mines in California and Oregon whose operators were not heard from. Of the 5960 flasks produced, 4023 are credited to California, 1698 to Texas, 193 to Oregon and 46 to Nevada. No production was reported from Idaho or Arizona.

The quicksilver reported on hand at the mines or in transit to market at the end of the quarter amounted to 4419 flasks.

As was expected, the output during the first quarter of 1919 was considerably less than that during the first quarter of 1918, which was 8764 flasks. The decrease was 2804 flasks. The unsold stocks at the end of the first quarter of 1918 amounted to 2800 flasks, or 1619 flasks less than at the end of the first quarter of 1919.

The average monthly price of quicksilver in San Francisco, as quoted in the *Mining and Scientific Press*, for January was $103.75, for February $90, and for March $72.80.

The falling off in production is the result of a combination of causes, chief among which were a lessened demand for the metal and a consequent downward trend of prices, the continued high cost of labor and supplies, and the curtailment of underground exploration and development during the war, when energy was directed chiefly to immediate production. The price of quicksilver, compared with the prices that prevailed before the war, was still high at the end of the quarter, but not high enough to offset the general decrease in the tenor of the ore immediately available and the high cost of mining and treatment.

The Examination of Materials by X-Rays

A joint meeting of the Faraday and the Röntgen Societies was held April 29, 1919, in the rooms of the Royal Society. The chairman, Sir Robert Hadfield, in introducing the discussion, expressed his belief that in this method of examination there lay a great future for the detection of flaws in metals and other materials, such as wood and ferro-concrete, upon which the safety of human life often depended. Hitherto the method had been limited, so far as metals were concerned, in that it could be applied only to thin sections. Recently 4 in. of steel had been examined, and he believed that apparatus now in use would be able to penetrate iron and steel up to 9 in. in thickness.

Several interesting papers were presented dealing with the principles, apparatus and technique of radio metallography. Types of X-ray bulbs and tubes were discussed. The behavior of photographic plates to X-rays and the methods of obtaining contrast in photographs through metals were the subjects of two papers.

The practical application of the method relating to the examination of metals was presented in a paper by E. Schneider describing "Researches Into the Industrial X-Ray Examination of Metals at the Laboratories at Le Creusot Works." This paper summarizes: (*a*) Researches into segregation and blowholes; (*b*) examination of tungsten steels; (*c*) examination of compound metals; (*d*) location of blowholes, in order to avoid them in working.

Capt. R. Knox, M.D., and Major G. W. C. Kaye, M.A., presented a paper on "The Examination of Aircraft Timber by X-Ray." No difficulty was experienced in detecting concealed knots, resin pockets and grub-holes. Excess or deficiency of glue in glued joints is also readily revealed. Workmanship and material in the interior of completed laminated or box spans and struts have every detail shown up by the X-ray. The center veneers of plywood can be examined by the same means. In most instances the fluorescent screen suffices for this kind of work.

The X-ray examination of alloy steels and the nonferrous alloys and metals was suggested as an adjunct to the usual metallographical methods. Prof. W. H. Bragg thought it probable that by means of the diffraction effects of X-rays caused by the atoms of a crystal we should be able to examine the nature and extent of the crystallization of substances and thus gain much information to supplement that given by other methods. He also brought out the fact that generally speaking the transparency of a substance is greater the smaller the atomic weight.

American Dye Industry

The present status of the American dye industry, both as to results obtained in spite of war-time difficulties and as to limitations in competitive ability, is clearly shown in a report submitted to the Committee on Ways and Means by the United States Tariff Commission. The report supplements and brings up to date the Census of Dyes and Coal-Tar Chemicals for 1917.

The production of intermediates has developed to such an extent that the industry is practically independent of imported raw materials; 354,808,315 lb., valued at $123,817,966, was produced during 1918.

The grand total of all finished products derived from coal tar (exclusive of explosives and poison gases) was 75,494,113 lb., valued at $83,095,404, reported by 162 firms. The total production of dye during 1918, reported by 77 firms, was 57,155,600 lb., valued at $61,306,040. This output in 1918 represents a gain of 24 per cent over 1917. Of even greater importance than the gain in output is the fact that over 300 dyes of improved quality were made during the year, over 100 of which represented varieties new to the American industry. In many cases prices of dyes were considerably reduced.

Synthetic indigo was manufactured by only one firm in 1917, the output being 276,000 lb. During 1918 two other firms entered the field, production increased to 3,083,888 lb., and it is stated that the present plant capacity is substantially greater than the pre-war importation, which, in 1913-14, was 8,507,359 lb. Over 12,000,000 lb. of sulphur black was made, as compared with 5,616,458 lb. imported during the fiscal year 1913-14. The corresponding figures for methyl violet, a triphenylmethane dye, are 632,196 lb. and 255,063 lb., respectively. Four azo dyes were produced in excess of one million pounds each; Alizarin yellow G, 2,233,208 lb.; scarlet 2R, 1,188,798 lb.; naphthylamine black 10B, 1,154,682 lb.; benzo blue 2B, 1,523,985 lb. Excellent progress is also reported in the preparation of coal-tar medicinals and photographic materials. It is interesting to note that the reported production of the highly-prized photographic developer metol (methyl-p-amidophenol sulphate) is 10,975 lb., which is 393 lb. in excess of the 1913-14 importation.

In spite of the rapid advance made by the industry, much remains to be accomplished before German competition can be met. The great group of dyestuffs derived from anthracene, which includes the fastest dyes known, is practically undeveloped in this country. During 1918 only 119,774 lb. of anthraquinone and related colors was produced, while 3,300,000 lb. was imported in 1913-14. However, much experimental work has been done on these dyes and, provided that Germany is prevented from dumping her reserve stocks on the American market, we may expect a substantial increase in production and variety. It will be necessary to improve the methods used for recovering anthracene, so that the residual pitch may still be marketable as a road surfacing material.

DYES AND WAR MATERIALS

As an instance of the close relationships existing between certain dyestuffs and war materials, the manufacture of sulphur black and picric acid is cited. The nitration of monochlorbenzol yields dinitrochlorbenzol, which may be converted into the sodium salt of dinitrophenol by boiling with alkali. This product gives sulphur black by treatment with sodium sulphide and sulphur, or, upon further nitration, picric acid which, in combination with calcium hypochlorite, forms chlorpicrin. It is obvious that a plant making sulphur black in peace times can quickly turn out picric acid and chlorpicrin in a war emergency. In addition, picric acid could be made from the phenol (produced synthetically from benzol or recovered during the fractional distillation of coal tar), used in peace times for the manufacture of germicides, medicinals, dyes, phenolic resins, synthetic tanning materials, etc. Normal consumption of phenol is estimated at 10,000,000 lb. per year, while the output for 1918 was 106,794,277 lb.

LICENSING SYSTEM PROPOSED

In order to determine the best method for protecting the dye industry during the final stages of its development, hearings were held before the Ways and Means Committee during the week of June 16. Joseph H. Choate, Jr., counsel for the Chemical Foundation and the American Dyes Institute, presented a brief showing the need for insuring a permanent domestic industry and outlining the proposed licensing system, which is not in the nature of an embargo, but is a temporary measure designed to admit those dyes which the Licensing Commission finds are unobtainable at reasonable prices from domestic sources. The Longworth bill for import duties on coal-tar products was accordingly rewritten to include a license system which will operate for five years to bar out all dyes and intermediates except as the American industry may need them. The Dye Licensing Commission is to consist of eleven members appointed by the President, five of whom will represent the manufacturers (three of these must be actually engaged in the manufacture of coal-tar dyes) and five the consumers (three of these must be actually engaged in the manufacture of cotton, woolen and silk goods, respectively). The remaining member, who will be the chairman, must not be connected with the dye industry, either as manufacturer or consumer.

Fall Meeting of the American Electrochemical Society

The tentative program for the Chicago meeting of the American Electrochemical Society, Sept. 23-25, 1919, has been announced by the board of directors. Several sessions will be held jointly with the American Institute of Mining and Metallurgical Engineers, which meets in Chicago during the week of Sept. 22.

On Tuesday, Sept. 23, the Society and Institute will go by boat to Gary, Ind., for inspection of the plant of the United States Steel Corp. A symposium on electric steel will be held on the boat and continued at the Congress Hotel in the evening.

Wednesday morning the Society will hold a general session and in the afternoon a joint session with the A. I. M. E. in a symposium on non-ferrous electrometallurgy. In the evening a special visit will be made to the electric furnace display at the National Exposition of Chemical Industries at the Coliseum.

Thursday will be devoted to a symposium on catalysis, to be followed by a smoker in the evening.

On Friday the Institute may hold its symposium on pyrometry, to which members of the Society are invited.

Headquarters of both the Society and the Institute will be at the Congress Hotel, and according to present plans all sessions will be held there.

The American Electrochemical Society's headquarters at the Chemical Exposition will be Booth 229, on the balcony of the Coliseum.

House Passes Water-Power Bill

The House of Representatives has passed the water-power bill in spite of the fact that it had become entangled in such a way as to jeopardize early action on it. The bill is substantially the same as the Administration measure which the House of Representatives passed at the last session of Congress and which the Senate failed to consider in the closing days of its session. The measure provides for the granting of fifty-year licenses to construct and operate hydro-electric projects in the United States. The Federal Water Power Commission, which is the licensing body, is composed of the Secretaries of Interior, War and Agriculture. Provision is made for the recapture of projects at the end of fifty years and for the regulation of rates.

The measure is now before the Commerce Committee of the Senate and will be taken up by a sub-committee of that body shortly after Aug. 1, when Senator Jones of Washington, chairman of the committee, is expected to return from a visit to Seattle. The other members of the sub-committees who will have jurisdiction over the bill for the time being are Senators Nelson, Lenroot, Bankhead and Fletcher. Friends of water-power legislation in Washington predict the early passage of the bill by the Senate, but in legislative circles at the Capitol it is well understood that the question of foreign affairs relating to the Peace Treaty and League of Nations will have an important effect upon the early passage of any legislation.

During the short debate in the House preceding the passage of the bill, attention was called to the fact that Congressional delay in providing for water-power development has been in large measure responsible for the power shortage that we experienced during the war, and that further delay should not be tolerated.

Notes and Data on Fixed Nitrogen Plants

COST figures at the Government's cyanamide process nitrate plant at Muscle Shoals were made public for the first time during the recent hearings before the Committee on Military Affairs of the House of Representatives. Tabulations were presented showing the detailed costs of manufacturing calcium cyanamide and ammonia gas, nitric acid and ammonium nitrate therefrom this spring when the plant was operated at 20 per cent of its capacity in a test run. An estimate is given also of the costs had the plant been operated at full capacity. No charges are made on such important accounts as interest on the thirty-odd million dollars capital invested or plant depreciation and obsolescence, taxes and insurance. Undoubtedly a very large percentage of the investment in the plant should be written off against war expenditures, as it was constructed at extraordinarily high cost to protect our army against any possibility of defeat due to nitrate supplies from Chile being insufficient or our inability to expand the by-product coal industry so as to obtain sufficient amounts of ammonia. General Williams, Chief of Ordnance, in reporting on nitrate reserve stocks estimated that 24 divisions (1,400,000 men) will use 400,000 tons of sodium nitrate per year. At the time of the signing of the armistice, Col. Burns reported that the Government possessed a stock of 700,000 tons of nitrate and an equivalent of 200,000 tons in finished explosives; 400,000 tons was turned over for agricultural use, leaving an equivalent of half a million tons for military reserve. This, in comparison with our 44,000-ton stock of nitrate at the beginning of the war, gives a good military index number.

In reply to Mr. Quin's question as to converting the

MANUFACTURING COST OF GRAINED AMMONIUM NITRATE AT U. S. NITRATE PLANT. NO. 2

	Results of Two Weeks' Test at Approximately 20 per Cent Capacity, Production 950 Tons			Estimated Cost of Manufacture at 100 per Cent Capacity, Production 110,000 Tons per Year				
Item	Quantity per Ton of Ammonium Nitrate	Unit Cost	Cost per Ton of Ammonium Nitrate	Quantity per Year	Unit Cost	Total Yearly Cost	Cost per Ton of Ammonium Nitrate up to June 1, 1921	Cost per Ton of Ammonium Nitrate after June 1, 1921
Nitric acid	0.858 ton	$103.37	$88.69	94,380 tons	$61.98	$5,850,000	$53.18	$57.41
Ammonia gas	0.230 ton	287.22	66.06	25,300 tons	169.19	4,281,000	38.91	42.49
Steam power, compressed air, misc	....	....	1.47	....	......	156,000	1.42	......
Labor	....	....	3.43	....	......	273,000	2.48	......
Total	....	....	$159.65	....	......	$10,560,000	$95.99	......
Overhead	....	....	4.22	....	......	200,000	1.82	......
Total	....	....	$163.87	....	......	$10,760,000	$97.81	$105.62
Operating fee	....	....	5.00	....	......	550,000	5.00	......
Total	....	....	$168.87	....	......	$11,310,000	$102.81	$105.62

MANUFACTURING COST OF WEAK NITRIC ACID AT UNITED STATES NITRATE PLANT NO. 2

(All figures computed on bases of 100 per cent acid)

	Results of Two Weeks' Test at Approximately 20 per Cent Capacity. Production 600 Tons			Estimated Cost of Manufacture at 100 per Cent Capacity. Production 94,380 Tons per Year				
Item	Quantity per Ton of Nitric Acid	Unit Cost	Cost per Ton of Nitric Acid	Quantity per Year	Unit Cost	Yearly Cost	Cost per Ton of Nitric Acid up to June 1, 1921	Cost per Ton of Nitric Acid after June 1, 1921
Ammonia gas	0.317 tons	$287.22	$91.05	29.920	$169.19	$5,070,000	$53.63	$58.56
Power, kw.-hr	344	.00738	2.54	32,500,000	.0045	146,000	1.55	......
Compressed air	....	....	......	....	......	....	......	......
Miscellaneous	....	....	1.95	....	......	232,000	2.46	......
Labor	....	....	3.96	....	......	136,000	1.44	......
Total	....	....	$99.50	....	......	$5,584,000	$59.08	......
Overhead	....	....	3.87	....	......	265,000	2.90	......
Total	....	....	$103.37	....	......	$5,849,000	$61.98	$66.91
Operating fee	....	....	3.20	....	......	302,016	3.20	......
Total	....	....	$106.57	....	......	$6,151,016	$65.18	$66.91

MANUFACTURING COST OF AMMONIA GAS AT UNITED STATES NITRATE PLANT NO. 2

	Two Weeks' Test at Approximately 20 per Cent Capacity, Production 350 Tons, Cost per Ton Ammonia			Estimated Cost of Manufacture at 100 per Cent Capacity, Production 55,220 Tons per Year				
Item	Quantity per Ton Ammonia	Unit Cost	Cost per Ton Ammonia	Quantity per Year	Unit Cost	Total Yearly Cost	Cost per Ton Ammonia before June 1, 1921	Total Yearly Cost per Ton Ammonia after June 1, 1921
Lime nitrogen	4,025 tons	$64.41	$259.25	222,260 tons	$37.65	$8,368,000	$151.54	$167.08
Soda ash	0.134 tons	41.60	5.57	7,400 tons	38.00	281,000	5.09	......
Steam	8,000 lb.	.217	1.74	442,000 M.	.181	80,000	1.45	......
Power, compressed air, and misc	....	....	1.02	....	......	48,000	.87	......
Labor	....	....	9.93	....	......	300,000	5.44	......
Overhead	....	....	9.71	....	......	265,000	4.80	......
Total	....	....	$287.22	....	......	$9,342,000	$169.19	$184.73
Operating fee	....	....	11.90	....	......	657,000	11.90	......
Total	....	....	$299.12	....	......	$9,999,000	$181.09	$184.73

MANUFACTURING COST OF CALCIUM CYANAMIDE AT U. S. NITRATE PLANT NO. 2

Item	Two Weeks' Test at Approximately 20 per Cent Capacity, Production 1450 Tons; Cost per Ton of Lime Nitrogen			Estimated Cost of Manufacture at 100 per Cent Capacity, Production 220,000 Tons per Year				
	Quantity per Ton of Lime Nitrogen	Unit Cost	Cost per Ton of Lime Nitrogen	Quantity per Year	Unit Cost	Total Yearly Cost	Cost per Ton of Lime Nitrogen up to June 1, 1921	Cost per Ton of Lime Nitrogen after June 1, 1921
Limestone	2 tons	$2.25	$4.50	440,000 tons	$1.75	$770,000	$3.50	.....
Coke	0.54 tons	9.75	5.26	118,800 tons	6.00	713,000	3.24	.....
Coal	0.26 tons	4.25	1.10	57,200 tons	3.50	200,000	.91	.....
Electrodes	44 pounds	.06	2.64	4,840 tons	120.00	581,000	2.64	.....
Power, kw.-hr	2,765	.00738	20.40	608,300,000	.0045	2,738,000	[1]12.44	.....
Miscellaneous materials	....	....	2.75	....	....	590,000	2.68	.....
Labor	....	....	11.35	....	....	1,014,000	4.61	.....
Total	....	....	$48.00	....	....	$6,606,000	$30.02	.....
Overhead	....	....	13.85	....	....	990,000	4.50	.....
Total	....	....	$61.85	....	....	7,596,000	$34.52	$34.52
Operating fee	....	....	3.12	....	....	686,000	3.12	.....
Royalties	....	....	2.56	....	....	689,000	3.13	6.99
Total	....	....	$67.53	....	....	$8,971,000	$40.77	$41.51
Preparing for fertilizer use	....	....	.....	....	....	550,000	2.50	2.50
Total	....	....	.....	....	....	$9,521,000	$43.27	$44.01

[1] When hydro-electric power from Muscle Shoals dam is developed we should be able to obtain power, under the same assumption as governs this table, at a maximum cost of $0.001 per kilowatt-hour. On this basis the cost of "cyanamide fertilizer" would be reduced from $40.77 per ton to $31.09.

nitrate plants over to the production of commercial fertilizer, Col. Burns said:

> I think that is a problem in itself, Mr. Quin. I doubt if anybody could give you a definite answer. I know that we hope to utilize the plants for manufacturing commercial fertilizer, but there are one or two problems that will have to be solved before one can definitely say that the scheme is feasible. In the first place, money has to be appropriated by Congress for the operation of the plants and we will undoubtedly have to prove to you that we have a commercial product. We know that we can produce cyanamide, which is an absolutely satisfactory material for war purposes, for the manufacturing of ammonium nitrate and other explosives, but cyanamide at present is not admitted to be a thoroughly satisfactory fertilizer.
>
> I doubt not that small amounts are satisfactory. When you mix cyanamide with the ordinary mixed fertilizers in very small quantities you get no toxic effects therefrom, but if you increase the percentage very materially you may get toxic effects. That is the subject of one of our lines of experimentation at the present time.

COMPARATIVE COST OF NITROGEN IN VARIOUS PRODUCTS

Item	Estimated Manufacturing Cost per Ton at No. 2	Market Price per Ton	Units of Ammonia per Ton	Price per Unit Ammonia
Cyanamide:				
Estimated manufacturing expense per present contract prior to June 1, 1921	$40.03	......	24	$1.67
Estimated manufacturing expense per present contract after June 1, 1921	40.77	......	24	1.70
Estimated manufacturing expense per present contract after June 1, 1921, assuming hydroelectric power from Muscle Shoals dam available	31.09	......	24	1.30
Ammonia gas:				
Estimated manufacturing expense per present contract prior to June 1, 1921	181.09	......	100	1.81
Estimated manufacturing expense per present contract after June 1, 1921	184.73	......	100	1.85
Estimated manufacturing expense per present contract after June 1, 1921, assuming hydro-electric power from Muscle Shoals dam available	145.32	......	100	1.45
Weak nitric acid (as 100 per cent):				
Estimated manufacturing expense per present contract prior to June 1, 1921	65.18	......	27	2.41
Estimated manufacturing expense per present contract after June 1, 1921	66.91	......	27	2.47
Estimated manufacturing expense per present contract after June 1, 1921, assuming hydro-electric power from Muscle Shoals dam available	53 22	......	27	1.97
Ammonium nitrate:				
Estimated manufacturing expense per present contract prior to June 1, 1921	102.81	......	42	2.44
Estimated manufacturing expense per present contract after June 1, 1921	105.62	......	42	2.52
Estimated manufacturing expense per present contract after June 1, 1921, assuming hydro-electric power from Muscle Shoals dam available	84.72	......	42	2.02
Ammonium sulphate, normally	......	60.00	25	2.40
Sodium nitrate, at present	......	81.50	19	4.29
Sodium nitrate, normally	......	45.00	19	2.37

An agricultural research is now being made and it is expected that the present difficulties will eventually be overcome.

Plants Nos. 3 and 4 at Toledo and Anchor, Ohio, are to be salvaged. Six million dollars has been spent on each of them and they are only 20 per cent completed. Twelve million dollars has been used in the construction of No. 1, but certain process troubles have prevented operation. A commission has been sent to Germany to study the Haber process, a modification of which was to be used.

Blast-Roasting and Its Effect on Blast-Furnace Design

BY WALTER K. MALLETTE

MODERN blast-roasting has resulted in great improvement in metallurgical practice at smelters throughout this country, and this has led to changes in design of various parts of the plant. This is more noticeable in the design of the modern blast-furnace than in any other part of the works.

Sintering of fine sulphides and the agglomeration of other fine material in this sintered product has resulted in a much coarser and more open charge in the furnace. This coarse charge offers less obstruction to the passage of the blast and has greatly increased the tonnage output of the blast-furnace. This improvement is much more noticeable in lead furnace practice than it is in the copper plants, where reverberatories have largely supplanted blast-furnaces.

A few years ago, blast-furnaces were invariably designed with a short, abrupt bosh directly above the tuyeres. This bosh was ultimately eliminated from the end jackets and the ends of the furnace made straight. The necessity for a bosh of this type has been largely eliminated by blast-roasting of ores and the resultant coarsening of the furnace charge, as it is no longer necessary to support the charge at a point above the tuyere line in order to permit the blast to penetrate to the center of the furnace.

A modern lead blast-furnace, where sintering eliminates the fine material from the charge, should be designed with a gentle, continuous bosh from crucible to the top of the jackets and with perpendicular ends. The slope, or bosh, will depend upon the reduction in volume of the descending charge, the rate of descent being kept uniform from the top of the furnace to the tuyere line. The Bunker Hill furnaces are of this type and operate very satisfactorily.

The day of the brick top, supported on mantel beams, has passed, and modern practice is to use two tiers of water jackets surmounted by cast iron or cast steel plates. This provides a furnace unusually free from incrustation and eliminates the necessity for cutting the blast and barring down accretions. It also gives less obstruction on the furnace floor and, consequently, better working conditions.

The greater porosity of the furnace charge makes it desirable to increase the height of charge column so that, in place of the 15 or 16 feet which has usually been considered the best working height, 22 to 24 feet may now be carried with far greater success. This necessitates greater blast pressure and allows a slight increase in furnace width, so that an up-to-date lead furnace should have a width of about 50 inches, a charge column height of about 22 feet and use a blast pressure of about 60 ounces.

Such a furnace will operate with very little trouble. The higher blast-pressure will give a zone of intense action near the tuyere line and the furnace will be free from blow-holes. The elimination of hot tops reduces the dust losses and the high blast-pressure enables the furnace to handle variations in charge with great ease.

COMPROMISE WITH AUSTRALIAN PRACTICE

Riddell has pointed out some of the advantages observed by him in Australia on furnaces of this type, although the Australian practice goes to limits which are hardly applicable to the majority of ores in this country. It is rare that we would encounter conditions which would warrant a furnace 56 in. in width with a 27-ft. ore column. However, we can compromise between this extreme and our previous practice to material advantage.

The thimble top, adopted in some instances, seems to offer advantages, although it is doubtful whether this can be universally applied. At the Selby plant this method of drawing off the gases presents distinct advantages as hand feeding is still in use. The thimble, with stack or downtake protruding through the feed floor, adds complications to mechanical feeding, but it is quite possible that the thimble could be designed with the downtake below the feed floor, leaving the latter clear for the operation of charge cars. A downtake on each end of the furnace, connected to the thimble, would give the best results.

It seems quite likely that Arthur Dwight's idea, to which he gave expression some years ago, of feeding the furnace by means of belt conveyors will be practically applied in connection with the use of the thimble top. It is certainly feasible and would undoubtedly result in a considerable saving of labor.

Increased tonnages of output of the lead blast-furnace will lead, ultimately, to a trapped spout and a continuous slag flow.* This has not been attained as yet, but the period between taps has been so reduced, in some instances, as to bring this condition within reach.

Double roasting has eliminated the matte problem so that it is quite possible to operate a lead blast-furnace without matte fall. However, this is of doubtful value, as the presence of a certain amount of matte in the furnace keeps it in better condition and is worth the cost of retreatment in the improved furnace conditions. Keeping the matte fall to 2 per cent gives excellent results in the majority of cases, and this amount of matte is a valuable material with which to regulate the condition of the roast. A judicious use of matte will assure a good hard roast under almost any conditions, and in order to operate the blast furnace with the greatest success, the physical as well as the metallurgical conditions of the roast must be closely watched.

REDUCTION OF MATTE FALL IN LEAD SMELTING

The reduction in matte fall has eliminated the great need for double settling, and the smelting of slag shells is also being gradually discarded, although there are still quite a number of metallurgists who maintain that a furnace cannot be successfully run without a bit of slag. With reduced matte fall and reasonable settling, the value of the slag shells is not much greater than in the discarded molten material and this will rarely pay the cost of rehandling and retreatment. It is more profitable to discard the shells and replace them with ores in which there is a margin of profit.

In the copper plants, the reverberatory still holds the front rank, but it seems likely that much of the work which is now done in the reverberatory furnace could be performed just as successfully in the blast-furnace in conjunction with blast roasting. There has been less change in the design of copper blast-furnaces than is the case with lead furnaces; blast-roasting cannot be said to have affected the design of copper blast-furnaces to any appreciable extent. The long Mathewson type of furnace is still in favor and continues to perform satisfactorily. Crucible plates have been lowered and are now set on I-beams resting on the foundations. Brick tops were eliminated a number of years ago and long, narrow jackets are very generally used.

The future may bring out improvements in copper blast-furnace design and practice which will make it once more a rival of the reverberatory, but it cannot be said to have been very greatly improved during the past five or six years.

601 Wells-Fargo Building,
San Francisco, Calif.

Mineral Acid Production.—Mr. A. W. Hawkes, vice-president of the General Chemical Co., recently stated that at the close of the war the company was producing mineral acids at a rate of 420,000 tons annually. This is about two-thirds that of all the plants in the British Isles. The total production of the United States grew during the war from 3½ to 7½ million tons of 50 deg. B., with plants under way for nine.

---

*Editor's Note—"Mathewson" top was in use in Pueblo for many years.

Electrolytic Caustic Soda-Chlorine Cells

Review of the Patent Situation—Four Classes of Cells Defined: Diaphragm, Mercury, Bell and Fused Electrolyte—Chart: Product Proportions, Current and Energy Efficiency, Kilowatt Consumption and Current Cost Per Unit of Products

BY KARL HORINE

THE basic patent[1] on caustic chlorine cells was granted to Charles Watt long before the era of dynamo generators and cheap electricity. Watt obtained his current from Daniel cells in series. Nevertheless prices were correspondingly high, for the chemical caustic soda and chlorine market still had fifteen non-competitive years ahead of it before Messrs. Solvay, Weldon, Deacon et al. were to initiate "The War of the Alkali Industry." Watt was an able chemist, as will be appreciated upon examining his patent description, which anticipates the actual development this process has taken, namely: Diaphram cells for the production of pure chlorine and alkali; fused electrolyte, metallic sodium, etc.; and mixed electrolyte, hypochlorites and chlorates.

Approximately three hundred inventors have received patents subsequent to Watt's invention. Billiter's[2] and Lucion's[3] Abstracts describe most of these. The former gives a digest of the patents on the diaphragm and bell type of cell on which there were 256 British, 136 German and 127 American patents granted previously to 1911. The American patents are in group 204—Electrochemistry, subdivisions 1, Aqueous Bath; 4, Anodes; 5, Apparatus; 6, Cathodes; 28, Diaphrams, and 58, Alkali and Chlorine. Less than twenty issues have been made since 1911 and a complete set of copies can be obtained from the Patent Office for about $7.

In conception the electrolytic method of making caustic soda and chlorine from brine is extremely simple. The requirements are merely a pair of electrodes and the passage of direct electric current from one to the other in the brine. The primary products formed in so simple a cell, however, would immediately enter into secondary reactions and not be available as desired. The numerous modifications of the simple cell that have been brought out represent just so many attempts to eliminate or control these secondary reactions. The merits of the several electrolytic processes will be better understood after reviewing the underlying facts of alkali chloride electrolysis.

AMPERE-HOUR EFFICIENCY

When a current of electricity is passed through a solution of common salt, positively charged sodium ions pass to the cathode (negative electrode) and negatively charged chlorine ions pass to the anode (positive electrode). The chlorine ions give up their negative charges on contact with the anode and are liberated as free chlorine gas or remain dissolved in the liquid surrounding the electrode. At the cathode the sodium ions give up their positive charges and immediately react with the water of the electrolyte, liberating hydrogen and forming caustic soda. Thus the products of electrolysis are chlorine, caustic soda and hydrogen, all of which are valuable commercially. Unless prevented by the construction and operation of the cell the following secondary reactions are presumed to occur in some degree: The hydroxyl ions formed at the cathode will carry negative charges to the anode exactly as the chlorine ions do. These hydroxyl ions, however, have almost three times faster migration velocity than have the chlorine ions and consequently carry, in proportion to their concentration, a larger part of the current. Arriving at the anode, the OH ions are discharged, with the result that oxygen is set free, together with the chlorine. The sodium hydroxide, which must be in equilibrium with the OH ion passing through the anolyte, reacts with the dissolved chlorine, forming hypochlorite, chlorates and sodium perchlorate in solution, a portion of which are reduced by the carbon anodes forming carbon dioxide in the chlorine gas. The chlorine dissolved in the anolyte may also come in contact with caustic by diffusion with the catholyte and bring about the same secondary reactions.

The aim of the various processes is to remove the products, chlorine, caustic and hydrogen, from the zones of electrochemical activity as rapidly as they are formed and so to avoid the secondary reactions. If this were accomplished, no current would be used in secondary reactions, and the current efficiency would be 100 per cent; that is, each ampere-hour would produce 1.3220 g. of chlorine, 1.4910 g. of sodium hydroxide and 0.03759 g. of hydrogen. Ampere-hour efficiencies obtained in practice vary from 90 to 98 per cent.

ENERGY EFFICIENCY

The energy efficiency depends not only upon the current officiency but also upon the cell voltage. The cell voltage may be considered as made up of two parts—the voltage of decomposition of the solution and that required to overcome the resistance of the solution and of the electrodes. The decomposition voltage of brine is approximately 2.3, and until the applied pressure exceeds this critical value no current is forced through the cell. Cells operate usually at from 3 to 7 volts, depending upon design, temperature and current density. If a cell had 100 per cent current efficiency and could operate at a pressure of 2.3 volts, its energy efficiency would then be 100 per cent. In practice energy efficiencies range between 30 and 75 per cent. The difference in voltage of different cells depends almost entirely on the current density and length of current path in the electrolyte. This is evident from the fact that the resistivity of 25 per cent or nearly saturated brine is 1.76 ohm-inch, or 2½ million times that of pure copper. Consequently a great area of electrolyte and a short current path are needed to avoid excessive voltage drop. In connection with the operation of plants for the production of chlorine and caustic soda electrolytically, it is desirable frequently to correlate various factors bearing on the cost of production. Repeated application of efficiency formulæ, calculations of kilowatt-hours per lb. of chlorine, etc., become irksome even when carried out on a well-oiled slide rule. As a short-cut the author has evolved the chart of co-ordinated curves shown herewith. The continued building of chlorine and caustic soda cells suggests that such a chart may be useful to others. It might readily be used by a plant operator or superintendent having no knowledge of the theoretical considerations on which it is based.

---

[1] Eng. Pat. 13,755, Sept. 25, 1851.

[2] Die elektrolytische Alkalichloridzerlegung, Part I, mit starren Metallkathoden, 284 pages. Part II, mit festen Kathodenmetallen, 180 pages.

[3] Electrolytische Alkalichloridzerlegung mit Metallkathoden (Hg or Pb).

The use of the chart requires little explanation in addition to the example given. The operating current and cell voltage are read from indicating meters usually mounted on the power board. The number of pounds of caustic soda per hour is computed from the weight and concentration of caustic liquor.

Four Classes of Cells

Electrolytic chlorine cells comprise four processes, namely, the diaphragm, the mercury, the bell, the fused electrolyte.

The Diaphragm Process. In this process a porous partition, usually a molded absestos compound, separates the anode and cathode compartments. All types of diaphragm cells employ the same means of preventing the hydroxyl ions from passing to the anodic space, that is, the flow of the electrolyte itself is made to oppose their passage. The gases, chlorine and hydrogen, accumulate above the surface of the electrolyte and are readily drawn off. The sodium hydroxide is removed from the cathode in part by the flowing salt solution and in part by gravity. Whether it collects at the top of the cathode compartment, as in Le Sueur's cell, or at the bottom, as in the Griesheim, Townsend, Jewell and others, depends upon the relative concentration of brine and caustic where a mixture of these solutions constitutes the catholyte. Thus the specific gravity of a 26.4 per cent or saturated salt solution at 15 deg. C. is 1.2, and the caustic soda will float on the brine unless its gravity is equal to or greater than 1.2, that is, unless its concentration is above 17.7 per cent. A number of diaphragm cells, however, use oil, steam or even air in the cathode chamber.

The earliest commercially successful cell of the diaphragm type was the Griesheim, which was first operated in Germany in 1890. An iron box serves both as container and cathode. The anodes are plates of magnetic iron oxide. The diaphragms forming the walls of the boxlike anode compartments are a composition of cement, salt and hydrochloric acid. In use, the salt dissolves and leaves an extremely fine pored wall. It is essential in all diaphragm cells that this porous diaphragm allow electric current to pass through freely, but at the same time keep the caustic alkali of the cathode compartment from mixing with the saturated salt solution of the anode compartment. In the Griesheim cell the accumulation of the sodium hydroxide causes the waste of current from secondary reactions to increase and when about one-third of the sodium chloride has been decomposed it is necessary to shut down and draw off the caustic. Griesheim cells are steam-jacketed and the electrolyte temperature is maintained between 80 and 90 deg. C. The anode current density is from 10 to 20 amperes per square foot. Other diaphragm cells in operation are the Hargreaves-Bird, in Middlewich, England; the Townsend, at Niagara Falls; Le Sueur's, at Rumford Falls, Maine; the Outhenin-Chalandre, used extensively in France, Switzerland, Italy and Spain; the Billiter-Siemens, at Niagara Falls and in Europe; the Billiter-Leykam, in Austria; the Finlay, operating in Belfast; the Allen-Moore, at Portland and Philadelphia; the Nelson, in West Virginia; the Wheeler, in Wisconsin, and the Jewell, in Chicago.

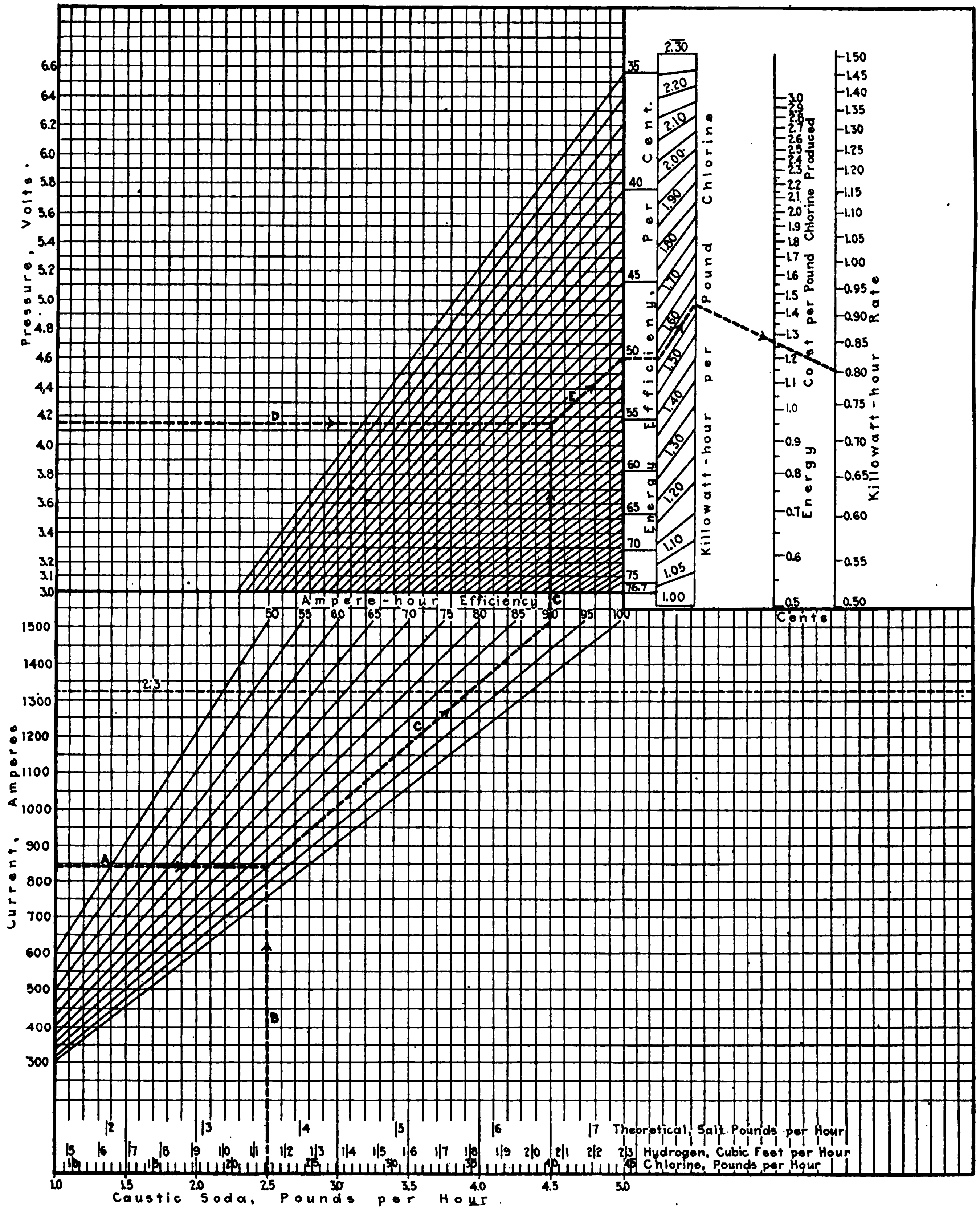
The Mercury Process. The mercury process uses anodes of carbon and a cathode of mercury. The sodium liberated by electrolysis amalgamates with the mercury and the amalgam is transferred mechanically to an adjacent compartment containing water. The amalgam is decomposed by the water, resulting in the formation of sodium hydroxide with the evolution of hydrogen and freeing of the mercury, which is returned to the electrolyzing chamber. Chlorine is collected above the anodes. NaOH so formed is very pure.

The Castner and Kellner cell in England was an early representative of this type. While the efficiencies are good, the initial cost is extremely high. A plant having a capacity of one ton of chlorine per day would contain about 13,000 lb. of mercury. Other mercury cells are the Solvay-Kellner, the Rhodin and the Wildermann.

The Bell Process. The bell type, of which the Aussig is the original, uses neither diaphragm nor mercury, but depends upon gravity for partial separation of the caustic soda and salt solutions. The chloride drawn off with the dilute caustic crystallizes out in the process of concentration of the caustic by evaporation. The Aussig comprises a bell of non-conducting material supported in an open tank. A carbon plate suspended horizontally inside the bell serves as anode and a sheet iron coating upon the outer surface of the bell constitutes the cathode. Brine is fed into the anode compartment. The current passes from the anode down under the edge of the bell and up to the cathode. Chlorine is drawn off through an opening in the top of the bell, while the heavy caustic formed at the cathode sinks and is drawn off at the bottom of the container. In practice a single tank contains twenty-five bells operating in parallel. The bell cells are free from diaphragm troubles, reliable in operation and low in initial and maintenance cost.

The Jewell bell-type cell is a modification of the older bell types. Stratification in its cathode compartment is aided by the addition of water and dilute caustic rises as formed. The Jewell claims ability to use impure brine, high current efficiency at high current densities and low cost for attendance and upkeep. The Jenkins is also a modified bell type of cell.

The Fused Electrolyte Process. This is also known as Acker's process and was at one time operated at Niagara Falls. The graphite pins which serve as anodes dip into a bath of fused salt. The salt floats on a cathode of lead maintained molten by the current it carries. The action is similar to that of the mercury process. The electrolyzed sodium forms an alloy with the lead, is removed from the cell and decomposed by steam to form sodium hydroxide and hydrogen. A current density of about 20 amp. per sq.in. of lead keeps the bath in a molten state. The concentration of caustic produced averages 94 per cent. The concentration of chlorine is 10 per cent, an extremely low figure. The energy efficiency is also very low.



ELECTROLYTIC CAUSTIC SODA-CHLORINE CELL CHART

Typical Solution of a Problem:

Given:

Operating current, *A* .... 840 Amp.
Operating pressure per cell, *D* .... 4.15 V.
NaOH produced per hour, *B* .... 2.5 lb.
Kw.-hr. rate .... 0.8 c.

Readings:

Lb. chlorine per hour, opposite 2.5 read 2.42
Theoretical lb. of salt per hour, opposite 2.5 read 3.66
Cu.ft. hydrogen per hour, opposite 2.5 read 11.4
Amp.-hr. efficiency, line *C* at intersection *A* and *B*, at end 90%
Energy efficiency, line *E* at intersection *D* with amp.-hr. efficiency, at end 50%
Kw.-hr. per lb. chlorine, on cross-scale, linear side, read . 1.58
Energy cost, align 1.58 and 0.8 on logarithmic scale read ... 1.26c.

On the basis of efficiencies shown in published reports, an enterprise contemplating the manufacture of chlorine would select the Finlay cell. The selection of the type of cell, however, and the installation of a plant happen to require many other considerations such as initial cost, attendance charges, upkeep, floor space, overload capacity, cost of energy, continuous or off-peak operation, market for products, etc. While it is not to be expected that complete and reliable data on these various features can be available in so new an industry, there are a number of outstanding characteristics of processes and of individual cells that bear on the above named factors.

While diaphram renewal is necessary in cells of the diaphragm type, it is looked upon rather as a matter of cell upkeep than as operating trouble. Where the brine is properly pretreated the cells are operated from six to twelve weeks or even longer without serious falling off in efficiency or output. The mechanical cleaning of diaphragms in operation has been suggested, but the nature of the stoppage would seem to make this impracticable, if not impossible. Chemical cleansing of the cell pores is also unpromising on account of the activity of the chlorine on one side and of the caustic on the other. The diaphragm type cells are the most satisfactory on the market at present.

Offsetting the many advantages of the mercury cell are the comparatively large investment and large floor space required and the difficulty of removing impurities from the mercury. The high fixed charges can be compensated only by low energy costs, mercury cells being thus limited to regions of abundant water power.

The bell type require comparatively large floor space. Their low energy efficiency is offset by low investment, upkeep, and attendance charges. The possibilities of increasing the energy efficiency by decreasing the operating voltage offers a promising field for experimenters. The voltage above the brine decomposition voltage (2.3) is used entirely in overcoming the internal resistance of the cell. Since the resistivity of the electrolyte is about 400,000 times that of hard cast iron and 5600 times that of carbon, it is evident that, as pointed out above, by far the greater part of the voltage drop in a bell cell is due to electrolyte resistance and a very small part to electrode resistance. The problem, therefore, is to increase the area and decrease the length of the path of the current in the electrolyte and at the same time provide for the removal of the products of electrolysis without the undesirable secondary reactions. Because the area of the electrodes usually varies with the area of current path through the electrolyte and therefore with the voltage, undue importance seems to have been attached to electrode area and electrode-electrolyte contact resistance. Experience has shown that density of current in the electrolyte is the factor of prime importance. If the electrolyte current density factor is taken care of at all points, there will be no question of electrode-electrolyte contact resistance.

The capacity of rating of a cell should be based on the output of products of standard purity with maximum energy efficiency. The overload capacity would then be defined as the maximum rate of production which gives such standard products regardless of energy efficiency. Capacity stated in pounds or kilos of chlorine per 24 hours is definite; expressions such as "a 2000-ampere cell," sometimes used, are without meaning in stating capacities.

The value of overload capacity in the economics of production depends upon the relation among a number of factors. It is evident that to increase the output increase of the current density is required, and to increase the current density higher voltage, resulting in lower energy efficiency and higher energy cost of production, is required, but the higher rate tends to decrease the cost of production by cutting down the fixed charges. It follows that there is a point of maximum economy readily determinable in any given case. Thus it was found that a certain plant operating with highest ampere-hour efficiency at two tons of chlorine a day could be operated most economically at four tons a day.

The character of load afforded the central station by electrolytic chlorine plants is most attractive. The low voltage energy of unvarying amperage may, for many types of cell, be taken directly from a rotary converter at the available pressure, say 110 to 500 volts. For example, a type of cell using 1500 amperes at 3.5 volts could be connected 30 in series on 110 volts, in which case the required converter capacity would be 165 kw. Such a plant would produce, say, 2880 lb. of chlorine per 24 hr. Voltage regulation is unnecessary. In addition to these attractive features, such a plant, if equipped with the proper type of cell, permits of off-peak operation.

The increasing demand for chlorine, its numerous products and its by-products must lead to the development of a recognized standard type of cell comparable in efficiency, durability and ease of operation with other standard electrical apparatus. This ultimate type of cell will doubtless have an energy efficiency above 80 per cent; it will operate with little attention, and its elements will require renewing infrequently as do those of a storage battery. Ordinary impurities in the salt and water will have no effect on its efficiency and will be periodically removed as simply as a boiler is blown off.

Many cells now in use cannot be shut down without taking special precautions to prevent mixture of brine and caustic, destruction of anodes, or other bad effects. The ultimate type will be unaffected by interruption of energy supply.

With the development of the efficient and dependable cell for the production of chlorine will come the development of simpler and safer methods for its utilization. Which of the fields of its present application will come to demand the bulk of the output it is impossible to foresee. Most interesting to the chlorine manufacturer, to the central station power salesman and to the industrial engineer is the fact that wonderful growth in the electrolytic chlorine industry appears to lie immediately ahead.

Civil Service Examinations

Metallurgist (Male).—A vacancy exists in the Navy Yard, Norfolk, Va., at $2800 a year. Bachelor's degree in metallurgy or mining engineering and at least three years' experience in metallurgy, including inspecting and testing of metals, are required. Applications must be filed prior to July 29, 1919.

Metallographist (Male).—A vacancy exists at the Engineering Experiment Station, Naval Academy, Annapolis, Md., at $7.52 per diem. Applicant must have bachelor's degree in chemistry, engineering or metallurgy and must have had not less than one year's experience in the use of the microscope in the examination of metals. Examination closes July 29, 1919.

The Langmuir Postulates

An Introduction to Dr. Irving Langmuir's Theory of Chemical Reactions, Showing the Method of Determining the Physical Qualities of Chemical Compounds From Their Atomic, Ionic and Molecular Structure — A New Theory of the Constitution of Atoms and Molecules

By ELLWOOD HENDRICK

I

THE address of Dr. Irving Langmuir delivered at the Buffalo meeting of the American Chemical Society on "The Arrangement of Electrons in Atoms and Molecules" made such a deep impression upon those who heard it, and the potentialities of the Langmuir postulates loom so large as applied to research, that we resolved to give our readers a report on the subject as soon as this could be made ready. The first original paper appeared in the June number of the *Journal* of the American Chemical Society. Owing to the intense concentration of the text it is not easy reading, even to the average chemist, and in what follows we shall not attempt to cover the field with thoroughness, or even to touch upon problems that require experience in applying the postulates. Our purpose is to write an introductory chapter, and to begin "further back" for the benefit of those who have not followed diligently the voluminous literature of research on the structure of atoms and molecules. We shall not even attempt to make the line clear between the Langmuir postulates and the work of other men in research whose conclusions are in part accepted. We are dealing with a new philosophy of chemistry which differs from that of the present text-books in various concepts, but which provides a definite means of determining upon the arrangement of atoms in combination, as well as that of electrons in atoms and molecules.

Practical Value of the Theory

We shall try to give at least a glimpse of its amazing practicality when applied in the laboratory. It is, in effect, a new angle of attack which calls for new mental processes; and, as with any new tool, these seem difficult at first. When we state, however, that with adequate understanding and experience, it becomes possible to predicate the physical and chemical qualities of a substance, even to its crystalline structure, before it is synthetized; that it opens up a new and workable theory of valence; that it explains the curious manifestations of the elements of the rare earths and other elements in the periodic table, the irregularities of nitrogen, and the magnetic properties of the iron and platinum groups of metals, as but a part of its contributions, we need give no further emphasis to its value as an aid to technology as well as to research. We shall not undertake to make all these facts clear. Our purpose is to lure the reader into a consideration of the subject, so that he may approach Dr. Langmuir's present and future papers with that quality of interest which is warranted by their importance.

For lack of space and with a view to confining ourselves to the simplest features in this article we shall omit discussion of the principle involved in the secondary planes (Postulate I) in connection with the position of electrons in atoms of greater complexity, also the magnetic forces as indicated in Postulate V, and the illumination shed upon the great work of Werner, and refer the reader to the first paper in the June number of the *Journal* of the American Chemical Society for the explanations and a much more comprehensive discussion of the entire subject in a very condensed form.

We are indebted to Dr. Langmuir for a number of extended interviews, and we express our sincere obligations to him for his patience in exposition.

Structural Resemblance of N_2O and CO_2

By way of indicating the workings of the theory let us take as an example two gases that we have not heretofore regarded as having any qualities in common: N_2O, or laughing gas, and CO_2. According to the Langmuir postulates, as we shall try to develop them in part, these gases display a remarkable resemblance in the structure of their molecules, containing each the same balanced number of positive and negative charges, and the same exterior arrangement of electrons, so that, were they magnified to visibility, and the kernels of the atoms hidden from view, we should be unable to tell them apart by looking at them. At least it is a fair guess that by looking at them, under these conditions, we should be unable to distinguish them, one from the other. Then we conclude that they must have certain physical properties in common. The figures which follow have not been published elsewhere at the present writing; we are indebted for them to Dr. Langmuir, who will present them later on with detailed explanation in the *Journal* of the American Chemical Society, but they will serve to indicate the points of remarkable similarity in the physical properties of two gases which Dr. Langmuir concludes to be similar in structure. The records are taken from unrelated pages of published works:

	N_2O	CO_2
Critical pressure, atmospheres	75	77
Critical temperature, deg. C	35.4	31.9
Viscosity at 20 deg. C	148×10^{-6}	148×10^{-6}
Heat conductivity at 100 deg. C	0.0506	0.0506
Density of liquid at —20 deg. C	0.996	1.031
Density of liquid at —10 deg. C	0.856	0.858
Refractive index of liquid, D line 16 deg. C	1.193	1.190
Dielectric constant of liquid at 0 deg. C	1.598	1.582
Magnetic susceptibility of gas at 40 atmos., 16 deg. C	0.12×10^{-6}	0.12×10^{-6}
Solubility in water, 0 deg. C	1.305	1.780
Solubility in alcohol, 15 deg. C	3.25	3.13

Both gases form hydrates, $N_2O.6H_2O$ and $CO_2.6H_2O$. The vapor pressure of the hydrate of N_2O is 5 atmospheres at 6 deg. C., while the hydrate of CO_2 has this vapor pressure at —9 deg. C. The heats of formation of the two hydrates are given respectively as 14,900, and 15,000 calories per gram-molecule.

The surface tension of liquid N_2O is 2.9 dynes per sq.cm. at 12.2 deg., while CO_2 has this same surface tension at 9.0 deg. C.

Thus N_2O at any given temperature has properties practically identical with those of CO_2 at a temperature of 3 deg. lower.

These results indicaate the similarity of the outside structure of the molecules.

DISAGREEMENT IN FREEZING POINT

There is one property, however, that is in marked contrast to those given above: the freezing point of N_2O is —102 deg. C. while that of CO_2 is —56 deg. This may be taken as an indication that the freezing point is a property which is abnormally sensitive to even slight differences in structure. The evidence seems to indicate that CO_2 is slightly more symmetrical and has a slightly weaker external field of force than that of N_2O.

It would be hard to find such an array of coincidences unless there were reasons for them, and it is one of the purposes of this paper to show reasons for them, as we proceed.

All of these figures have been gathered by painstaking research in the past. They were uncorrelated and uninteresting. But in the light of this theory we find them ranging themselves into such subtle correlation as to cause them to function as parts of that greater whole which men of research are ever trying to discover. For decades these figures have been available. But in this case, as in that of other bodies which we shall consider later, the identical physical characteristics of those of like structure have remained unobserved.

II

At the end of the paper we present the postulates upon which the work is based, and we shall refer to them from time to time as we proceed. But, going "further back," as we promised to do, let us consider every atom as made up of two component parts: the electro-positive charges concentrated in the nucleus of each atom, which is individual and peculiar to each element, and the electrons which are electro-negatively charged, and which, from their positions about the nucleus, neutralize the positive charges on it. *The electrons are arranged in a definite configuration about the nucleus of each atom.* They are not of necessity held absolutely still. There is no reason why they may not move about, but the area of activity of each electron that forms a part of an atom is circumscribed within limits of space similar to that of its neighbor. Unlike the nuclei which, as we have just said, are held to be peculiar to each element, we consider the electrons to be all alike.

Now let us bear in mind the atomic numbers of the elements in the order of their atomic weights in the periodic table. They are: H, 1; He, 2; Li, 3; Be, 4; B, 5; C, 6; N, 7; O, 8; F, 9; Ne, 10; Na, 11; Mg, 12; Al, 13; Si, 14; P, 15; S, 16; Cl, 17; Ar, 18; K, 19; Ca, 20; Sc, 21; Ti, 22; V, 23; Cr, 24; Mn, 25; Fe, 26; Co, 27; Ni, 28; Cu, 29; Zn, 30; through to U, 92.

ATOMIC NUMBER COINCIDES WITH ELECTRO-POSITIVE CHARGES

Thanks to the brilliant Moseley of Manchester, England, killed as a private soldier in the flower of his youth in the Gallipoli fight, we have confirmation of the statement that the atomic number of each element in the periodic table and the number of electro-positive charges on the nucleus of its atom are the same. Thus from the above we read that the number of positive charges on the nucleus of the hydrogen atom is 1; that of the lithium atom is 3; carbon, 6; nitrogen, 7, and so on, so that the table of atomic numbers is also that of the positive charges on the nucleus of the atom of each element. From this we gather also that the nucleus of the atoms of no two elements can be the same, and we learn, too, that the table of atomic numbers gives, in addition to the foregoing, the number of electrons that are attached to, and form part of, every atom of every element. There must be an electron to neutralize every positive charge, because the difference between an atom and an ion is that in the former every positive charge of the nucleus is satisfied with an electron, and is therefore neutral, while in an ion this is not the case. In an ion there are either more or fewer electrons than will completely balance the positive charge of the nucleus of the atom, or the nuclei of the atoms, which constitute it.

In acknowledging and accepting in part certain theories of W. Kossel and G. N. Lewis, Dr. Langmuir carries them further, with various changes and extensions, but, as already stated, for the sake of brevity we shall not attempt to indicate the specific authorship of each idea.

III

By themselves electrons repel each other, but in the presence of positive charges they show a disposition to arrange themselves into definite groups; they indidate a law, or series of laws, of configuration, and this is the first step in the present work. If, then, these groupings, these configurations, may be found complete in the most stable of the elements, and incomplete in others, we may infer that in the inert gases the electrons are satisfied, that they have fulfilled their tendency to conform to certain arrangements, and that the activity of other elements is due to the drive to conform as nearly as possible to the complete, and therefore inert, elements. The author of these postulates will have nothing to do with metaphysics in the development of his theories of the constitution of atoms and molecules, but we cannot resist the observation that in this pair-forming and octet-forming nature of electrons about positive charges we find suggested the tendency in nature toward a condition of balance and rest which is the basis of the great postulate of Gautama Buddha, and the substance of the ancient philosophy of the East.

HELIUM THE MOST STABLE ELEMENT

Different elements do not behave the same; they differ in their nuclei and in their arrangement and number of electrons, but in this striving to become as nearly as possible like the fixed gases we find the key to all chemical phenomena. It behooves us, therefore, first to consider the most stable element, which is helium. The atomic number of helium being 2, the positive charge of its nucleus is 2, and it has two electrons. How are these arranged? There being but two they cannot follow an isometric system: the simplest would be the tetragonal system, having, like the earth, a polar axis and an equatorial plane (Postulate I). We imagine these two electrons as held by the positive charges of the nucleus very much as though the nucleus were in the center and the electrons each in the half of a complete shell, say, like a walnut-shell, that surrounds it. Neither electron crosses the plane which divides these two hemispherical shells. We might picture, as in

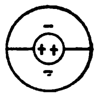


FIG. 1

Fig. 1, a cross section of the helium atom, cut a little above the equator, so as to show all charges, the positively charged nucleus indicated by ++ and each of the electrons by a — sign.

IV

This must be the most permanent arrangement of electrons about a nucleus: one electron in each half of a spherical shell, and neither trespassing upon the territory of the other. And while there is no reason to regard the electrons as stationary, save that each keeps within what we call its cell, it will be convenient for us to consider each as occupying its average position, which would be on an axis perpendicular to the plane which divides them. Here we have a complete satisfaction of the positive and negative charges with almost no force extending beyond the atom in any direction. Let us say the electrons have achieved a position of complete balance and contentment, thus making helium the most permanent substance known. Because there is practically no external force about the atoms, and the primary disposition of its electrons to form pairs is satisfied, the atoms do not form molecules; they remain independent and inert. So independent and inert are they that not only is He a gas, owing to the lack of external force about its atoms, but these atoms are readily separated, and its boiling point is therefore only 4½ degrees above absolute zero. We have, then, in helium, the achievement of the first electronic ideal: the grouping in pairs about a positive charge. Such a central part we consider to be common to all atoms except that of hydrogen: the nuclei varying from 2 to 92 positive charges, according to the element, and the first pair of electrons invariably next to the nucleus.

V

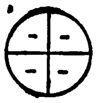


FIG. 2

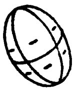


FIG. 3

The next element to helium in point of stability is neon. Its atomic number being 10, we must find an ideal arrangement of its ten electrons. The nucleus has ten positive charges, and the conclusion is that the first pair group themselves about the nucleus, just as in helium, leaving eight positive charges to be satisfied. These eight electrons arrange themselves in a second shell outside that containing the pair, four in either hemisphere of the outer shell, and each in its own cell. A top view would appear as in Fig. 2, with the nucleus and pair hidden under the outer shell. A perspective view would be as in Fig. 3. These eight electrons, four in either hemisphere of the outer shell, we call an octet. This shell is twice the diameter of that including the pair below it, and its surface is four times as great. This is in order to give the same space or room to each cell. There are eight cells, and every cell in the outer shell of neon is occupied. Now since we hold that chemical activity emanates mainly from the outer shell of electrons, there is no occasion for chemical activity in neon. And bearing in mind this greater chemical activity of the outermost shell we shall follow G. N. Lewis in calling all that part of any atom that is within the outer shell, its *kernel*. The second disposition of electrons is to group themselves into octets, and here they have done it. We have a pair, and an octet, all balanced, all filling every available space, and so there is no chemical activity to neon. It is inert; it is a gas; it has a low boiling-point, and it does not form molecules. It is completely satisfied as it is, and next to helium it is the most stable element. The next element in order of stability is argon, atomic number 18. This is just like neon, except that, according to Postulate IV, each cell of the second shell contains 2 electrons, making 2 in the first and 16 in the outer shell. This is also a permanent gas. In krypton, atomic number 36, we have two in the first shell, 8 + 8 in the second, and have 18 still to dispose of. The third shell will contain 18 electrons; 9 in each hemisphere. One of these 9 electrons will go to the pole, and the remaining 8 will be distributed symetrically about it. The same thing happens in the other hemisphere. With xenon we have krypton as the kernal (except that the nucleus has 18 more positive charges) and the 18 more electrons are distributed in the same manner in the third shell, making 2 in each cell, and including one more in a cell at each pole. Niton follows as the last, with 32 electrons in the fourth shell, 16 in each hemisphere.

In other words, we assume these inert and stable elements to be made up of successive and consecutive groups of electrons about the nucleus of each, consisting of first the nucleus, next a pair of electrons, and then consecutive octets and double octets with a pair in the polar position whenever there is an odd number of electrons to be provided for in each hemisphere. According to Postulate IV, all inner shells must have their full quota of electrons before the outer shell can contain any, but we note that in the inert elements the outside shells have their full quotas also. *This is the very reason for the stability and inactivity of these elements;* the electrons are ideally placed, they are electrically balanced, there is a minimum field of external force about the outer shells, therefore they all are gases, and have low boiling points.

No element other than the inert gases has its outer shell satisfied, i.e., every cell of its outer shell occupied, and therefore the electrons in the outer shell are always striving to make pairs or octets with some other electrons. *This is the basis of all chemical combination and reaction.* We shall try to make this more evident as we proceed.

VI

When we consider hydrogen, atomic number 1, we have but a single charge and a single electron. We have not even a pair. The lone electron is ever trying to form a pair, and therefore the atoms pair off in molecules. Note, please, in Postulate VI that a stable pair may be held by *two* hydrogen nuclei. Of course the hydrogen molecule is not as stable as an inert gas, but compared with a single hydrogen atom which has an exceedingly short time factor for its separate existence, the hydrogen molecule is very stable. It has the lowest boiling point of all substances except He, being but 20 deg. absolute. Due to such complete saturation within itself its external force is slight, and it shows slight chemical activity until it is split up into atoms. The old *status nascendi* theory in regard to hydrogen worked well in that it referred really to unpaired hydrogen atoms. If we take from a hydrogen atom its single electron we have left of course the hydrogen ion.

Lithium with its atomic number of 3 has three electrons, of which two form a pair about its nucleus and which constitute the lithium ion, while the third is easily detached, because it tends to form pairs or octets. We read in Postulate VI that the two atomic kernels can very rarely hold a pair of electrons as is the case with the H molecule. The lithium kernel already has its pair, and therefore it cannot get another nucleus into its kernel. The lithium atom with but one electron in its second shell produces a strong electrostatic field which extends into surrounding space. There being no free nuclei about which the single outside electrons can group themselves into pairs or octets, it is electrostatic force which holds the atoms together, a second upon the first, a third upon the second, a fourth upon the third, and so on, *ad infinitum,* so that it appears to build itself into a solid lattice work structure. Therefore it is a solid. It melts and boils with difficulty. Because of the free electrons it is a good metallic conductor, but for lack of enough available electrons to form octets on the outer shell it has no tendency to form molecules either in a solid, liquid or gaseous state.

PROPERTIES OF FLUORINE IN THE LIGHT OF THE THEORY

Fluorine has the atomic number 9, or one less than neon, so that it has a pair about the nucleus and seven in its outer shell, lacking but one electron to make the octet complete. The cumulative effect of its seven outside electrons to form an octet is so great as to give it intense chemical activity. If brought into contact with lithium it takes the electron from it and completes its octet, making the fluorine ion negatively charged, and leaving the lithium ion positive. Let us repeat this to make it clear. Fluorine has nine positive charges on its nucleus, and about it is, first, a pair of electrons, and then seven more in its outer shell. With seven electrons all placed in a shell with eight cells, and all seven trying to form an octet, the effort is likely to be intense. And it is. Nobody ever called fluorine inert! That lone extra electron of lithium in an outer shell (although, of course, the concept of shells and cells is a concept of space only) is pulled over to the vacant space in the fluorine outer shell. That leaves the lithium ion free. But with nine positive charges on the nucleus of fluorine and ten electrons now engaged, the fluorine ion becomes negatively charged because of ten eletcrons about its nucleus with + charge of 9. So too the lithium ion, which has a triple positive charge on its nucleus and has lost an electron, has now but two instead of three negative charges, which makes the lithium ion positive. The force, however, which holds this ion to the fluorine ion with its octet of electrons is electrostatic; there is no opportunity for pairs of electrons to be held in common by the two elements, therefore there is no LiF molecule. Every lithium ion is attracted to all the negative fluorine ions about it, and *vice versa,* so that it builds up a lattice work of the two ions, as in Bragg's salts. It is a solid, but it is a non-conductor, because there are no free electrons, every octet being satisfied. If, however, we melt it, then it becomes an electrolytic conductor, because the ions are then free to move around.

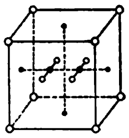
RELATIVE CHEMICAL ACTIVITY OF HALOGENS

Here is an illuminating note which explains why the halogens decrease in chemical activity as they increase in atomic weight, and therefore in atomic number, while with the alkali metals the opposite is the case. Not only does fluorine stand next to neon, but all the halogens stand next to the inert gases, each having one electron less. Chlorine bears this relation to argon, bromide to krypton, and iodine to xenon. But as these inert gases increase in atomic number they become less stable, as is indicated by their decreasing ionization potentials and their increasing boiling points. There is greater distance or greater interruption between the positively charged nucleus and the negatively charged electrons in the outer shell as atomic numbers increase. Therefore it stands to reason, among the halogens, that as they increase in atomic number their electro-negative qualities decrease in intensity. On the other hand lithium stands next to helium, and the other alkaline metals bear a similar relation to the inert gases, each having one electron more rather than one less, as with the halogens. This lone electron on the outer shell is given up in the presence of a positive charge; it cannot well draw on seven other electrons to complete the octet. But the electrostatic force between the nucleus and the outermost electron becomes less and less as the kernel grows larger and larger, because the distance between the positively charged nucleus and the outermost electron becomes greater. Therefore the outermost electron becomes more readily detachable as the size of the atom increases, so that sodium is more electro-positive than lithium, while potassium is more electro-positive than sodium.

Carbon, atomic number 6. Here the atom is composed of a pair of electrons about the nucleus, and four in the outer shell. By virtue of the larger charge in the kernel these are not easily given up, as in lithium, but may be regarded as constantly trying to draw on four more electrons to make up an octet. The atom is symmetrical, and its tetravalency is persistent. Its well balanced but incomplete structure explains both its permanency in combination and its high boiling point.

NITROGEN AND ITS COMPOUNDS

Nitrogen, atomic number 7, with 7 electrons, cannot be brought into any symmetrical shape by doubling up its atoms to form N_2. We have the nucleus with its pair, and then five more electrons in its outer shell, which has room for eight, and the five electrons in the outer shell always trying to form an octet. The only symmetrical form in which we can consider two nitrogen atoms to constitute a molecule is to have them slide together into one, with two nuclei in the centre, each with a pair of electrons, which accounts for four of the 14 electrons in two atoms of nitrogen, leaving ten over. In the outer shell we have eight, and the remaining two may be held imprisoned within the octet. The arrangement (in a tetragonal form) would be as in Fig. 4. We saw a different kind of doubling-up in the hydrogen molecule, and it seems that this assumption for N_2 and a few other gases is a happy one.



Nitrogen Molecule
FIG. 4

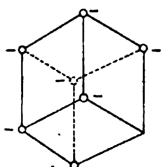
Nitrogen forms a series of unusual compounds, some of which are remarkably active and explosive, and its structure indicates a signal departure in properties from the elements that precede it in atomic number. This single octet with a double kernel is not unique with N_2 although it is unusual. It is the only symmetrical arrangement of certain other bodies, and gives rise to some remarkable comparisons; more particularly of N_2 with CO, and also between these and HCN and NO. Let us compare the N molecule with the CO. The N molecule we have indicated above, with two nuclei, and a total of 14 positive charges, and a pair of electrons about each nucleus, two more imprisoned, and a complete octet in the outer shell. The CO molecule is like it, with its 14 electrons arranged as in N_2, but with the two nuclei differently charged, being one nucleus with a positive charge of six for carbon and one with eight for oxygen, but also making a total of 14. The outer shells of these two bodies are the same, but their kernels differ. Now let us observe how these two gases resemble each other in physical properties for the very reason that their structures are so much alike.

	CO	N_2
Freezing point in deg. abs	66	63
Boiling point in deg. abs	83	78
Critical temperature	122	127
Critical pressure, atmospheres	35	33
Critical volume	5.05	5.17
Solubility in H_2O at 0 deg. C	3.5	2.46
Density of liquid at boiling point	0.793	0.797
Viscosity, $\eta \times 10^6$ at 0 deg. C	163	166

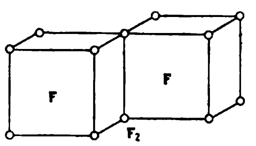
VII

The above is another remarkable example of physical similarity, due to what Dr. Langmuir calls isosterism; to similarity of the molecular structure of the two bodies. But in order to get what follows clearly in mind and to explain why we have pictured the N and CO molecules as tetragonal in shape rather than as spherical, let us enter into further explanation, even at the expense of repetition:

The helium atom with its nucleus and pair of electrons is the type of the innermost shell of every atom; the difference being only in that the nucleus has two positive charges, while the others, except hydrogen, have more positive charges. Since neither electron crosses the equatorial plane, we picture the atom as a nucleus, surrounded by a spherical shell, and each electron as placed within a fixed hemisphere of the shell. There is no reason to feel convinced that the electrons are held in a position of absolute stability, although we must assume that the position of each is circumscribed by the boundaries or walls of its cell. And we can well maintain that its average position is the center of its cell. When two electrons are in a cell we consider them to be placed, as to average position, one above the other, so that when, for instance, two octets are within a shell, we consider these two octets as in layers of eight. Since, according to Postulate I the central shell is divided only by an equatorial plane and the polar axis extending through the second shell and beyond is perpendicular to this equatorial plane, we have in an octet, a symmetry of electrons like that of a tetragonal crystal. Now, having conceived the atom as a sphere, it may seem an undue stretch of the imagination to call it a cube, but from the beginning we have claimed that the positions of the electrons are arranged with tetragonal symmetry. And since from now on we shall deal with electrons as they are arranged in the atoms, and since shells and cells are merely concepts of space, we shall picture every atom containing an octet as cubical in form. The octet is completed, then, when every corner of the cube contains an electron. Shells that contain more than eight electrons contain always multiples of eight cells, if we disregard those that are placed in the polar axis.



Fluorine Atom
FIG. 5



Fluorine Molecule
FIG. 6

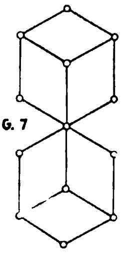
Suppose we go back for a minute to the fluorine atom with its nine electrons. There is the nucleus with its pair, and seven corners of the cube engaged. Let's make a working picture of it, Fig. 5. Then another fluorine atom will mate with it to form a molecule, as in Fig. 6. There are 16 corners of the two octets or cubes, all engaged, and each with an electron, but in two places one electron is in a corner of both cubes. The pair of electrons is shared, in other words.

VIII

Now let us develop the theory of octets which forms the basis of what Dr. Langmuir calls *covalency*, to distinguish it from valency in the generally accepted term. We shall not have much trouble here, if we address ourselves to the problem of observing how it works. The main difficulty is that we must take a new point of view, and anything new is likely to be bothersome.

The Langmuir theory of chemical combination is that these cubical atomic structures want to cover their corners with electrons so as to form complete octets. That is the way they try to complete their octets so as to settle down in life as much as possible like the inert gases, which is the electronic ideal. And we must remember that these cubes do not connect up on their corners. One electron held in common, as in Fig. 7, never holds two atoms together. They connect up either edge to edge, or side to side, so that there is either one pair of electrons, or two pairs, held in common by two combined atoms as in Figs. 8 and 9. It is very rare that the atoms coalesce, as in nitrogen, carbon monoxide, etc., for only under pressure of grim necessity will one atom join with another, making a single cube of two. The rule is as we have stated, either in single or double pairs between two atoms.

FIG. 7



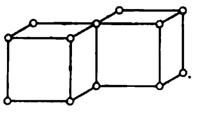


FIG. 8

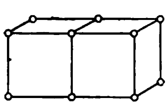


FIG. 9

DETERMINATION OF COVALENCY

This is covalency, and Dr. Langmuir has developed the following equation which shows us the necessary structure of the combinations from which we can determine the covalency.

$$e = 8n - 2p$$

or

$$p = \frac{8n - e}{2}$$

in which e is the total number of electrons available in the outer shells of all the atoms of a molecule; n is the number of atoms capable of forming octets, and p is the number of pairs of electrons held in common by the octets. (Postulate VIII.) Another symbol in frequent use is E, which indicates the number of available electrons in the outer shell of an atom. Available electrons means those forming incomplete octets, or, as with hydrogen, incomplete pairs. Thus, for instance, $E = 1$ for H, Li, Na, etc.; 2 for Be, Mg, etc.; 3 for B; 4 for C and Si; 5 for N and P; 6 for O and S; 7 for the halogens, and zero for the inert gases because the octets are complete and the electrons therefore unavailable.

The equation expresses the fact for every pair of electrons held in common between octets, there is a total of two less—a decrease of two—in the number of electrons contained in the outer shell of all the atoms of a molecule. In other words, two of the electrons, the pair that is held in common by two octets, serve for the same edge in two atoms. This we explained in regard to the fluorine molecule.

COVALENCY DEFINED

The formation of molecules of compounds, therefore, depends upon the formation of octets, except in the case of hydrogen, of which the ion (which is the nucleus of this element) takes its place between two electrons. *Then the covalency of an atom is the number of pairs of electrons that it shares with adjacent atoms.* We shall soon see that covalency is not the same as valency, although covalency is in full accord with the valency theory in connection with organic compounds wherever formulas are written with carbon having a valency of 4; nitrogen 3; oxygen 2; hydrogen 1. But when it has been necessary to assume a valency of 5 for nitrogen and phosphorus; 4 or 6 for sulphur; 3, 5 or 7 for chlorine, then it gives results totally different, but in better agreement with the facts.

We can get a better idea, however, of the working of covalency by applying the rule. Let us use as our example a familiar salt, $NaNO_3$. Repeating the equation $p = \frac{8n - e}{2}$ we have one electron available from Na which has the atomic number 11, and is therefore like neon, but with one more electron which is available in the outer shell; 5 for the nitrogen atom as we have already explained (N having atomic number 7 and so having 5 in the shell outside of its nucleus and pair) and 3 times 6, or 18, for O_3. So: $e = 1 + 5 + 18$, or 24. There are 24 available electrons in all the atoms of the compound. Then n, or the number of atoms capable of forming octets, would be 1 for nitrogen and 3 for O_3. Sodium with its one lone electron in the outer shell will give it up rather than gather on seven more, so Na is incapable of forming an octet. Therefore $n = 1 + 3$, or 4. Then $p = \frac{8n - e}{2}$ or $\frac{(8 \times 4) - 24}{2}$ or $\frac{8}{2}$ or 4. Now let's make a picture of it in Fig. 10.

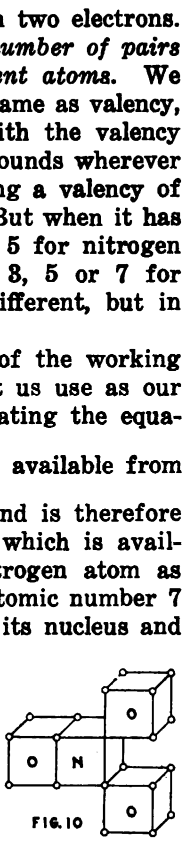


FIG. 10

THE PLAY OF ELECTROSTATIC FORCE

Here we have two octets complete, with four pairs, held by octets in common. It provides for our NO_3 and it took an electron from the Na atom to do it, leaving the Na ion out in the cold; the Na ion being, of course, the Na atom with its one available electron extracted. But since the Na ion is positively charged we do not need any inexplicable valency to hold it on; it will stick on of itself.

The Na ion is positive because it has lost an electron which has wandered over to complete the octets in NO_3. The Na nucleus has 11 positive charges and this ion has but 10 electrons, so it must be positive. Conversely, the NO_3 ion is a negative, because its atoms, originally electrically neutral, have taken up the extra electron from the sodium atom. To make this abundantly clear let us note that the total positive charges on the nuclei of NO_3 (7 for N, and 3 × 8 for O_3) are 31, while there are 32 electrons in the ion: 24 in the shells and 8 altogether in the 4 kernels. It must be negative, therefore, with 31 positive charges and 32 electrons negatively charged. So with an opposing charge for each of the two ions, positive for that of sodium and negative for NO_3, we have no need of other valency. The electrostatic force will hold all the positive and negative ions together, not in molecules, but built into a lattice of the entire mass, in alternate fashion, each Na ion attracting all the NO_3 ions about it, and vice versa. They do not produce molecules; they produce balanced Na^+ and NO_3^- ions, held together by electrostatic force.

When $NaNO_3$ is molten it becomes an electrolytic conductor, because under the influence of an electric field its ions are able to move. In solid $NaNO_3$ the ions already exist, and when it is brought into contact with water the high dielectric constant of this weakens the electric field which holds the ions together, allowing them to separate, which accounts for the ready solubility of the $NaNO_3$ in water. And, dissolved in water, it is, of course, a good electrolytic conductor because the ions are already separated from one another.

It is interesting to note that only within the past year three remarkable papers have appeared, by Milner in England, Ghosh in India, and Bjerrum in Germany, showing from different viewpoints and from independent work that strong electrolytes are completely ionized, even in a strong solution. The octet theory leads inevitably to the above conclusion, and apparent discrepancies in the law of mass action are thus accounted for. The same method of argument applies to all salt-like substances, and in all these salts the covalency of the metal ions is zero. They do not form molecules because their ions are held together by electrostatic force and not by covalency, that is, by the sharing of pairs of electrons between them.

IX

The theory of covalency becomes simple with practice, although it lacks the *ipse dixit* quality of the valence theory. It cannot be learned by heart; in every instance it has to be reasoned out, but by the aid of the octet equation the complete picture may be rapidly visualized. We have already stated that it is in full accord with, or is the exact equivalent of, the valence theory in connection with organic compounds when the formulas are written with a valency of 4 for carbon; 3 for nitrogen; 2 for oxygen, and 1 for hydrogen, but that the results differ when it is necessary to assume a valency of 5 for nitrogen and phosphorus, 4 or 6 for sulphur; 3, 5 or 7 for chlorine. These will be explained in future papers by Dr. Langmuir, in which such compounds as those of phosphonium, sulphonium, oxonium, diazonium, etc., are particularly well accounted for. The method of application, however, is somewhat similar to that of ammonium, which we shall now consider. In the meantime we must bear in mind that 4 is the highest covalency an atom can possibly have, because no atom can engage itself with one or more others by sharing over 4 pairs to form an octet.

In NH_4Cl the octet rule shows that p (or pairs of atoms held in common) $= \frac{8n - e}{2}$ in which n (the number of atoms capable of forming octets, being Cl and N but not H) is 2, and e (or total number of all the electrons available in all the atoms) is 7 for Cl, 5 for N, and 4 for H_4, or 16. So we have $p = \frac{16 - 16}{2}$ or 0. so that the N and Cl atoms have no pairs in common, although each is capable of forming octets. Then the hydrogen nuclei, being positively charged because they have each lost one electron, will tend to dispose themselves, each one between two electrons on the nitrogen octet. Their electrons have gone; one to complete the chlorine octet and the remaining three to do this same with the nitrogen atom. Now these hydrogen ions can also distribute themselves, one to the chlorine atom and three to nitrogen to produce HCl and NH_3, but by attaching themselves each to the four pairs of electrons on the nitrogen ion there is achieved a greater symmetry, and the hydrogen ions will do this until the temperature is so increased as to drive the nitrogen and chlorine ions apart from each other. Then one of the hydrogen ions, having its electron taken by chlorine, will follow it, and pair off with it between two electrons, giving us NH_3 and HCl. But with ammonium chloride we have as its two parts $NH_4{}^+$ and Cl^-. The ammonium ion is positive for the obvious reason that, with five nuclei, there are 11 positive charges, 7 for nitrogen and 4 for H_4, and only 10 electrons negatively charged to match them. On the other hand, the Cl^- ion carries in its complete octet one more electron (taken from a hydrogen atom) than the number of positive charges on its nucleus, and therefore it is negative. The equation taught us that the number of pairs shared by octets was 0. Ammonium chloride therefore is a salt, the ions $NH_4{}^+$ and Cl^- are held together by electrostatic force, and so it does not form molecules; in solution the ions become separated, and therefore it is an electrolytic conductor.

We observe from this nitrogen cube with an electron at every corner, and hydrogen ion held by every pair of electrons, that NH_5 is impossible. It also indicates why NCl_5 does not exist. $NH_4{}^+$ is an ion, and not a compound because it contains one hydrogen nucleus that lacks its electron, which in this case went over to the chlorine atom. There is nothing to indicate a valency of 5 for nitrogen in the octet theory.

SIMILARITY OF AMMONIUM AND POTASSIUM COMPOUNDS

A curious feature of the $NH_4{}^+$ ion is that it is surprisingly like the CH_4 molecule. They have the same number of electrons, the same structure, and they differ only in the electric charges of their respective nuclei. The hydrogen ions are held in the same way; both carbon and nitrogen forming complete octets, and both have hydrogen ion for every respective pair of electrons in the outer shell. Let us note at this point that the potassium ion—the potassium atom with one electron taken from it—is similar in structure to the argon atom except for the fact that the argon nucleus carries 18 positive charges and the potassium nucleus 19. Argon and CH_4 are very similar in their boiling points, etc. The fields of force of Ar and CH_4 are very similar, and the potassium ion differs from Ar just as the NH_4 ion differs from CH_4. Now things that differ equally from similar things are similar to one another, and it stands to reason that the K ion and NH_4 ion are as closely related to each other as are argon and methane. Therefore the K and NH_4 salts should be similar. And they are with remarkable frequency isomorphous in their crystal forms, and similar in their solubility and other physical characteristics. The same argument may be used to show that the NH_4 ion resembles the K ion much more closely than it does that of Na, since the Na ion has a structure like that of neon, in that it differs from it only in the electric charge of its nucleus. Ne being 10 and Na 11. Since neon does not resemble CH_4 as closely as does argon, it follows that the Na ion does not resemble the NH_4 ion as closely as does that of K, and the conclusion is amply supported by the physical characteristics of their respective salts.

X

Isosterism. We have already considered pairs of substances which when found to be closely related to each other in their several structures, prove to have remarkable relationships. When two substances have the same number and arrangement of electrons they are said to be isosteric. N_2 and CO are examples and show isosteric resemblances. If, then, besides the isosteric quality they have the same total number of positive charges in their kernels (or in all the nuclei in the molecule) then we shall expect the external field of force to be approximately the same in both cases, leading to approximate identity in physical properties. If the nuclei differ in their total charge, then one of the isosteres may be electrically charged when the other is not, so that the forces around the respective molecules become very different; then most of their properties will also differ.

RELATIONSHIPS OF ISOSTERES

This subject of isosterism abounds in evidences of the reasonableness of the Langmuir postulates and we find that closely related structures show closely related physical relationships, so that we can even trace them beyond the isosteres. We have noted the similarity of structure of the CO and N_2 molecules, which are true isosteres. We have seen that because of the isosterism of CH_4 and $NH_4{}^+$ and that of Ar and K^+ and from the similarity of CH_4 and Ar, it follows that $NH_4{}^+$ and K^+ are similar, although not isosteric. We cannot compare atoms with ions, but we may reason that if Ar resembles CH_4 then an ion that is isosteric with argon will also resemble another ion that is isosteric with CH_4.

If two substances, besides being isosteres in having the same number and arrangement of their electrons, have also the same number of positive charges on the nuclei of all their atoms, then we have a right to expect the external field of force to be approximately the same in both cases, and that they will have approximately identical physical properties. On the other hand, if the positive electric charges on the nuclei of the atoms of two or more isosteric substances differ, then the forces around the respective molecules will differ, and most of their physical properties will differ. Thus the potassium ion and the argon atom, although isosteric, are differently charged, and we find them totally different in their physical and chemical properties. But we can make use of their analogies to other bodies, and thus trace out relationships which are of great aid in indicating the probable nature of these substances.

We shall give a number of instances of isosteric substances with observations made by Dr. Langmuir which will form parts of articles to appear later in the *Journal* of the American Chemical Society.

We gave early in this paper the coincidence of figures in relation to the properties of N_2O and CO_2. Now we can undertake to give the reason for them. The octet rule shows $p = 4$ for both. So we have three cubes—three blocks, let us say—to be put together so they have four pairs of electrons or edges jointly. The simplest form would be three in a row, and we have N-O-N, or N-N-O as in Figs. 11 and 12. And we have covalences—in this case of 4 for O and 2 for N; or 4 for one N and 2 for the other N. and 2 for O. CO_2 must be O-C-O, Fig. 13, and we then have $\overset{7+}{N}\ \overset{8+}{O}\ \overset{7+}{N}$ or 22 positive charges on the 3 nuclei. With CO_2 we have $\overset{8+}{O}\ \overset{6+}{C}\ \overset{8+}{O}$ also 22 positive charges on the nuclei of its 3 atoms. There are 24 corners to the three cubes, but as 4 pairs of electrons are held in common we need 24 — 8 electrons, or 16 electrons, in the outer shell of each molecule—and there they are!

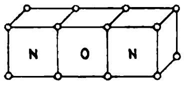


FIG. 11

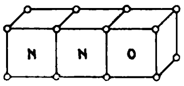


FIG. 12

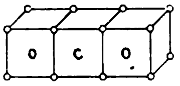


FIG. 13

Let us cite a few other examples, more particularly with reference to the crystal forms: ClO_4^-, SO_4^{--} and PO_4^{---}. These are isosteric, therefore we should find similarities in the crystals of their salts. Investigation brings out the following: $CaHPO_4$ and $NaHSO_4$ crystallize in triclinic pinacoids, showing the following axes and angles of their axes:

	a	b	c	α	β	γ
$CaHPO_4$...	0.6467	1	0.8244	84° 57′	89° 43′	85° 38′
$NaHSO_4$...	0.646	1	0.837	85° 06′	88° 57′	86° 47′

or almost wholly within the limit of experimental error, notwithstanding the marked difference in solubilities and similar physical properties.

These observations infuse life into Groth's otherwise dreary *Chemische Krystallographie.*

Again, $KClO_4$ and $SrSO_4$ are isosteric; they belong to the orthorhombic system, and show the following ratios of their axes:

	a	b	c
$KClO_4$	0.7817	1	1.2798
$SrSO_4$	0.7790	1	1.2802

Double refraction is positive in both and they show the same cleavages. They are, as are the others, typical cases of isomorphism, and thus afford direct experimental proof that $KClO_4$ and $SrSO_4$ have similar constitutions. The octet theory indicates that the central atom in both compounds has a covalency of 4. The usual viewpoint of the chemist is that the valency of Cl in $KClO_4$ is 7, while that of sulphur in $SrSO_4$ is 6. But the fact that these compounds are isomorphous encourages the belief that the rutinary theory with valencies of 7 for Cl and 6 for S is wrong.

ISOSTERIC NATURE OF APPARENTLY UNRELATED COMPOUNDS

Here follow more preliminary notes, to be dealt with in detail later by Dr. Langmuir:

$SrHPO_4$ and $KHSO_4$ are orthorhombic-pyramidal in form; their angles of axes are:

	a	b	c
$SrHPO_4$	0.8607	1	1.9344
$KHSO_4$	0.8581	1	1.9431

The optical axis in each is in (001) plane, and the habitus of the crystal forms are practically identical.

NaF and MgO are isosteric and are isomorphous in their crystal structures, according to measurements recently made by the X-ray method by Dr. Hull.

Corresponding salts of HN_3 and HCNO are isosteric, and the data in the literature, as far as they go, show that their solubilities are the same.

KN_3 and KCNO are both tetragonal: their ratios of axes are below:

KN_3	1 : 0.5798
KCNO	1 : 0.5766

Both give strong negative double refraction, and both have (001) and (111) as their most common crystal faces.

Let us conclude the list with mentioning a couple of salts that never were supposed to show any twin-like qualities: $Na^+NO_3^-$ and Ca^{++} CO_3^{--} which are almost identical in crystalline form, optical properties and cleavage. This is now accounted for by the fact that the NO_3^- and CO_3^{--} ions are isosteric. Since the force holding the Ca^{++} and CO_3^{--} ions together is four times as great as that holding Na^+ to NO_3^- it is more difficult to separate the ions, from which we understand why $CaCO_3$ is but slightly soluble, whereas in $NaNO_3$ the ions are easily separated in such a dielectric solvent as water, and that when the ions are separated, $NaNO_3$ becomes an electrolytic conductor.

XI

The theory, as may be observed, opens up vast possibilities. We can imagine periods of perplexity and dizziness after we have tried with sticks and balls of wax to build up atoms and molecules in the almost infinite number of chemical possibilities and we almost dread the task. It is usually difficult to present things of three dimensions in drawings of two, and the Langmuir atoms and molecules and compounds are all of three dimensions. We may have been somewhat negligent of this concept rather than ignorant of it in our methods heretofore. Whether this generation will take its chemistry in cubical atoms and build up its molecules and compounds in block-houses according to these postulates rests in the lap of the future for determination, but we think them too full of promise to be neglected for years as was Willard Gibbs' phase rule. We regard the work as a contribution of the first moment to the science of chemistry. And we believe that, as they are developed and revised and applied in practice, they will become familiar and easy of comprehension. We subjoin a revised list as of the postulates prepared for a forthcoming article on the subject by the author of the system.

XII

THE LANGMUIR POSTULATES

I—The electrons in atoms are either stationary, or rotate, revolve, or oscillate about definite positions in the atom. The electrons in the most stable atoms; namely, those of the inert gases, have positions symmetrical with respect to a plane passing through the nucleus at the center of the atom. No electrons lie in the equatorial plane. There is an axis of symmetry (polar axis) perpendicular to the equatorial plane through which four secondary planes of symmetry pass, forming angles of 45 deg. with one another. These atoms thus have the symmetry of a tetragonal crystal.

II—The electrons in any given atom are distributed through a series of concentric (nearly) spherical shells, all of equal thickness. Thus the mean radii of the shells form an arithmetric series 1, 2, 3, 4, and the effective areas are in the ratios $1; 2^2; 3^2; 4^2$.

III—Each shell is divided into cellular spaces or cells, occupying equal areas in their respective shells, and distributed over the surface of the shells according to the symmetry required by Postulate I. The first shell thus contains 2 cells, the second, 8; the third, 18, and the fourth 32.

IV—Each of the cells in the first shell can contain only one electron, but each other cell can contain either one or two. All the inner shells must have their full quotas of electrons before the outer shells can contain any. No cell in the outside layer can contain two electrons until all the other cells in this layer contain at least one.

V—When the number of electrons in the outside layer is small these electrons arrange themselves over the underlying ones, being acted on by magnetic attractive forces. But as the charge on the kernel or the number of electrons in the outside layer increases, the electrostatic repulsion of the underlying electrons becomes predominant, and the outer electrons then tend to rearrange themselves so as to be as far as possible from the underlying ones.

VI—The most stable arrangement of electrons is that of the pair in the helium atom. A stable pair may also be held by: (a) a single nucleus; (b) two hydrogen nuclei; (c) a hydrogen nucleus and the kernel of another atom; (d) two atomic kernels (very rare).

VII—The next most stable arrangement of atoms is the octet, that is, a group of electrons like that in the second shell of the neon atom. Any atom with the atomic number less than 18 and which had more than three electrons in its outside layer tends to take up enough electrons to complete its octet.

VIII—Two octets may hold one, two or sometimes three pairs of electrons in common. One octet may share one, two, three or four pairs of its electrons with one, two, three or four other octets. One or more pairs of electrons in an octet may be shared by the corresponding number of hydrogen nuclei. No electron can be shared by more than two octets.

History of Prices During the War

The Price Section of the War Industries Board is preparing a series of bulletins covering thoroughly the whole field of prices from the beginning of 1913 to the end of 1918. These bulletins will be completed and issued as soon as possible.

There will be 57 in all, the first seven being of a general nature. Each of the remaining fifty will be devoted to an important industry and of these the following (numbered from 30 to 57 in the order given) will be of interest to chemists and metallurgists:

Rubber and rubber products; paper; fibers and fiber products; iron, steel and their products; ferro-alloys, non-ferrous and rare metals; coal and coke; petroleum and petroleum products; matches; clay products; sand and gravel; quarry products; cement; glass; lumber; paints and varnishes; mineral acids; heavy chemicals; miscellaneous inorganic chemicals; fertilizers; soaps and glycerine; essential oils, flavoring and perfumery materials; wood distillation products and naval stores; natural dyestuffs and tanning chemicals; coal tar crudes, intermediates and dyes; drugs and pharmaceuticals; proprietary preparations; explosives; miscellaneous organic chemicals.

Melting Point of Asphalts

By Leland M. Proctor

As ASPHALTS or bituminous materials are not true chemical compounds, but rather an intimate mixture of a large number of different compounds, they have no definite melting points. That is, there is no critical temperature which can be observed at which they pass from a solid to a liquid state. Therefore, a stated melting point will depend upon the method used and the conditions under which it is observed, and is purely arbitrary. Each method will give a different temperature for the melting point, and thus the method should always be given when writing of the characteristics of bituminous substances.

The following data were obtained on asphalts manufactured: No. 1, from Mid-Continent residual oil; No. 2, from a mixture of Mid-Continent and Mexican residual oils; No. 3, from Mexican residual oil; and No. 4, from a mixture of Mexican residual oil and residual oil from the Burton process. These asphalts have very different physical characteristics apparent to the casual observer. Four different methods, the Richardson ball, or over mercury, method, the General Electric method, the Kramer and Sarnow method and the ball and ring method, were used for these tests.

Table of Chemical and Physical Characteristics

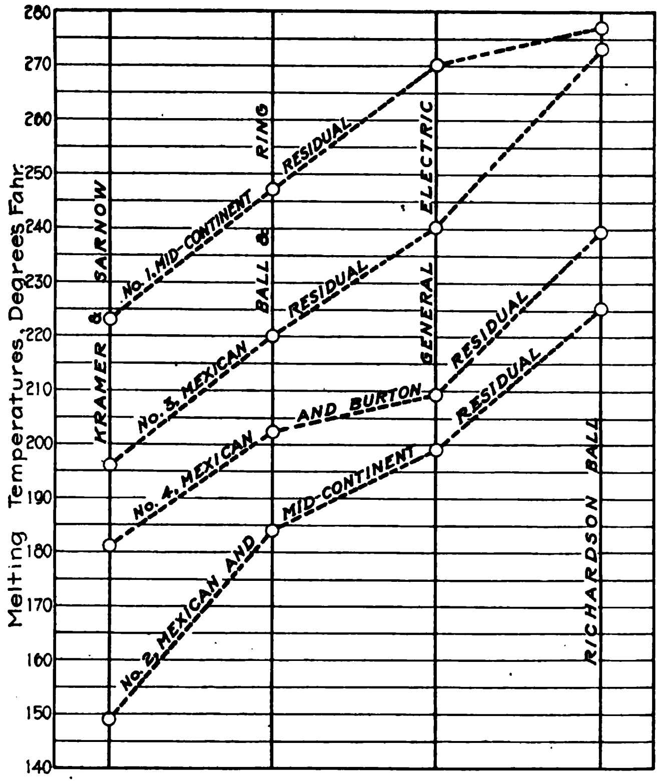
The following table of chemical and physical characteristics will give a much better conception of the asphalts used:

	No. 1	No. 2	No. 3	No. 4
Carbon tetrachloride soluble........	98.79	98.47	99.05	82.90
Carbon bisulphide soluble...........	99.87	98.94	99.47	97.59
Ethyl ether soluble................	75.82	71.95	67.28	69.71
Naphtha soluble, 88 deg............	87.50	76.45	96.28	77.36
Fixed carbon......................	17.78	19.57	24.44	28.40
Mineral matter as ash..............	0.14	0.048	0.421	0.163
Penetration at 77 deg. F., 100 g., 5 sec.	23	17	13	3
Ductility at 77 deg. F. in cm........	2.00	3.20	3.2	0.10
Specific gravity at 77 deg. F........	1.0026	1.028	1.054	1.135
Flash point (open cup).............	506	468	471	444
Burning point (open cup)...........	582	584	558	519

A short description of each method follows. It is not the aim here to give them in any great detail, as these can be more accurately obtained from some of the few good texts on the subject of bitumens. Failing access to these, however, they are given sufficiently fully to enable one to carry out the operations and to obtain results which will be accurate within the limits of manufacturing.

The Richardson Ball or Over Mercury Method

The apparatus consists of 150 cc. beaker about half filled with mercury, mounted on an iron stand, with a thermometer suspended so that the bulb is immersed in the mercury. On the surface of the mercury is placed a miscroscope slide, thus forming a mirror. The sample of asphalt is rolled into a sphere about the size of a French pea, heating, if necessary, to free from all nicks and creases. This is placed on the microscope slide and the top of the beaker covered with a cardboard to protect the sample from drafts. Heat is applied in such quantity that the temperature is raised at the rate of 10 deg. F. per minute. When the ball is first placed on the slide it appears with its reflection as two spheres, one over the other, touching at a single point, but as the temperature rises it gradually flattens out on the bottom until the melting point is reached, which is the point at which the half round sample and its reflection make a single sphere.



AVERAGE EQUIVALENT MELTING POINTS BY K & S, BALL & RING, G. E. AND RICHARDSON TESTS ON FOUR ASPHALTS

THE GENERAL ELECTRIC METHOD

A small quantity of the asphalt is melted and the bulb of a thermometer immersed in the liquid, withdrawn, and while the asphalt is cooling the thermometer is rotated horizontally. The process is repeated until enough material adheres, when it is rolled on an amalgamated brass plate, until a cylinder slightly smaller than a pencil is obtained. With a hot knife the lower end is cut off so that it is of uniform thickness throughout. The thermometer is now inserted in a cork, cut so as to reveal the graduations on the thermometer scale, and placed in a test tube so that the end of the thermometer is one inch from the bottom of the tube, and the whole is placed in a sulphuric acid or a glycerine bath so that the level of the liquid is above the top of the sample in the thermometer. Heat is then applied in such quantity that the temperature rises 5 deg. F. per minute. As the temperature rises gradually the sample slips on the thermometer and the point at which it first touches the bottom of the test tube is taken as the melting point.

THE KRAMER AND SARNOW METHOD

A small quantity of asphalt is melted in a suitable dish and the end of a glass tube 5 mm. inside diameter and about 8 cm. in length is thrust in to a depth of about 7 mm., withdrawn and the asphalt allowed to cool while the tube is rotated horizontally. When the asphalt is sufficiently cooled so that it no longer flows, the asphalt adhering to the outside of the tube is cleaned away and 5 g. of mercury is placed on the asphalt in the tube. The tube is secured to the thermometer so that the sample and bulb are at the same level, and both are suspended in a glycerine bath. Heat is applied in such quantity as to rise at the rate of 4 deg. F. per minute. As the temperature rises the mercury gradually sinks out of sight, forming a pocket, and the point at which it breaks through and falls to the bottom of the beaker is taken as the melting point.

THE BALL AND RING METHOD

The ball is polished steel, $\frac{3}{8}$ in. in diameter, weighing between 3.45 and 3.5 g. The ring is of brass, $\frac{5}{8}$ in. inside diameter, $\frac{1}{4}$ in. deep, with walls $\frac{5}{32}$ in. thick, fastened at right angles to a wire. A small quantity of asphalt is melted in a tablespoon and poured into the ring, which is set on an amalgamated brass plate, allowing for shrinkage. When it is cool the excess is cut off with a hot knife and the ball set on the asphalt in the ring. The wire is inserted in one hole of a two-hole cork and through the other a thermometer is inserted so that the bulb is at the same level as the ring, and the whole is suspended in a glycerine bath 1 in. above the bottom of the beaker. Heat is applied in sufficient quantity to raise the temperature at the rate of 10 deg. F. As it is heated the ball gradually sinks into the asphalt, coming through and forming a pocket with the ball inside. The temperature at which the pocket touches the bottom of the beaker is taken as the melting point.

COMPARATIVE DETERMINATIONS

As will readily be seen, there is no relation between the melting point as specified by one method and that of another method, each giving a different temperature.

Sample	Richardson Ball	General Electric	Kramer and Sarnow	Ball and Ring
FIRST TEST				
No. 1	275	271	214	246
No. 2	225	203	141	174
No. 3	271	236	191	219
No. 4	236	214	175	198
SECOND TEST				
No. 1	275	266	233	249
No. 2	224	193	152	187
No. 3	273	243	196	214
No. 4	239	205	181	204
THIRD TEST				
No. 1	277	274	223	248
No. 2	226	202	156	190
No. 3	276	242	200	226
No. 4	243	208	186	204
AVERAGE				
No. 1	276	270	223	247
No. 2	225	199	149	184
No. 3	273	240	196	220
No. 4	239	209	181	202

A study of the tables shows this fact very strikingly, that there is a decided difference in the melting points as taken by the different methods and also that for any two asphalts having different characteristics the difference is not the same. Thus, taking the method giving the highest results, the Richardson ball method, the following table of differences can be obtained:

Asphalt	ΔT Richardson Ball and General Electric, Deg.	ΔT Richardson Ball and Kramer and Sarnow, Deg.	ΔT Richardson Ball and Ball and Ring, Deg.
No. 1	6	53	29
No. 2	26	76	41
No. 3	33	77	53
No. 4	30	58	27

This variation can be accredited only to the difference in the character of the asphalts. No. 1 is a short fibered, comparatively soft, very slow melting paraffine base asphalt greasy to the touch. No. 2 is a long fibered, soft, tenacious, slow melting mixed base asphalt. No. 3 is a long fibered, comparatively hard, tough asphalt base asphalt. No. 4 is a hard, brittle, shining bright, quick melting, mixed base asphalt.

The Richardson ball method gives very close checks, is rapid, simple and several different samples can be run at the same time. It can be taught very easily to the ordinary workman and thus lends itself nicely to the purposes of factory control. The apparatus can be easily cleaned by dipping the slide into the mercury while hot and wiping with a cloth. It has this disadvantage, the personal error enters in to a greater extent than in any others in the matter of judging when the ball is completely down and in estimating the size of the sample.

The General Electric method gives fair checks, but is unsuited to factory control on account of the slowness—only one can be taken at a time unless a number of thermometers and tubes are used—and the work of cleaning the tube is tedious. The personal error enters in the rolling of the cylinder on the thermometer to a little less than the size of a pencil.

The Kramer and Sarnow method gives rather the poorest checks of these four methods, though some texts credit it with far greater accuracy than was obtained in these tests. The method is more or less complicated and tedious, taking more apparatus than any of the others in that the mercury must be weighed out within reasonable limits. As many different samples may be tested as can be conveniently observed at the same time, but this advantage is balanced by the time necessary to clean the apparatus.

The ball and ring method has been adopted by the American Society for Testing Materials as a standard for this class of materials, and gives very good checks. The method is well adapted to specifications, because when the conditions are standardized the results may easily be duplicated by any other observer, the personal error being practically eliminated. It is not, however, very well adapted to factory control, as but one sample can be tested at a time.

Lockland, Ohio.

The Explosion of Chemicals—I Common Law Liability

By Chesla C. Sherlock

The legal liability of an employer for injuries caused to his workmen by means of the explosions of chemicals which they are required by the duties of employment to work with must necessarily divide itself into two classifications—common law liability and the liability under the workmen's compensation acts. While the common law liability is not so generally operative as it was a few years ago, it still remains in many jurisdictions, so a consideration of the question can by no means be complete without first discussing it. Besides, the workmen's compensation system springs out of the common law system and its abuses, so that a complete understanding of the common law liability is necessary before any light can be cast upon the liability under the compensation acts.

Under the common law, it was a settled principle that the employer should provide his workmen with a reasonably safe place in which to work, safe appliances and tools and give them competent instruction in the use of such tools and as to the best manner of carrying on the work to be done. Furthermore, if the employer, by reason of his superior knowledge or position to acquire knowledge, should know of facts which might endanger the workman, it was his duty to warn the workman of these dangers and risks, especially in the case where the workman was young, inexperienced or new at the work.

In the case of dangerous tools or appliances or materials complicated in nature, it was the duty of the employer to exercise care and caution to keep them in a state of repair or to handle them in such manner that they did not become dangerous through defective condition or operation to the workman. If the employer lagged in this respect, he was very apt to find himself guilty of negligence and liable in an action for damages to the injured workman.

On the other hand, through long continued following of precedents and customs in determining what the law was, a great maze of decisions raised a barrier around the injured workman so that in obtaining his recovery he was put to such lengths that it was practically impossible for the average workman to realize anything for his injuries. What he did recover generally went for the costs of litigation and attorneys' fees.

Among these rules, the common law held that if a workman were guilty of contributory negligence, no matter how slight that negligence might be, he could not recover damages from his employer for the injuries suffered. If he was injured by the negligence of a fellow servant, he could not recover from the employer for the injury sustained, because the employer could not be held responsible for the negligence of another person, even though that person were his employee. If the workman was injured in the course of his employment by some risk incident to the employment, he was considered to have assumed the risk and could not recover.

These were the main rules of the common law applicable to employers and their employees. We will now consider them in the light of decisions handed down by the courts in specific cases dealing with the explosion of chemicals.

In an Iowa case, a drug clerk was mixing a compound of explosive nature. He ascended his ladder to get another ingredient, leaving the mixture on the shelf below. The mixture being compounded was explosive only to force or blows. He failed to tell another clerk who was working at a soda fountain of the dangers lurking in the compound. The latter went to the mixture and attempted to stir it. An explosion occurred injuring the latter. He sought damages.

The court held that "No duty which a druggist owes his employees with respect to furnishing a safe place to work is violated by leaving a mixture which is being compounded by an experienced pharmacist and is explosive under a blow or force in an open mortar while the one at work upon it ascends a ladder to secure other chemicals." The court also held that the employer was not guilty of negligence for a failure to warn the clerk at the soda fountain of the dangers attending the mixture.

In a Michigan case, a flashlight mixture was being compounded. The employee stated that, as usual, in preparing the mixture, he mixed together equal parts of powder and magnesium, when in some unaccountable manner the mixture exploded. The evidence tended to disclose the fact that powder and magnesium are not explosive and that the combination of the two when mixed in equal parts was not explosive, that they would not and never had exploded in the experience of the witnesses. The court was of the opinion that some substitute had been used in place of the magnesium and held that it was for the jury to determine. An award had been made by the lower court in favor of the employer, but this decision was reversed.

In a Missouri case, it was claimed that the employer had been guilty of negligence in permitting an employee to put potassium in water during a fire, whereby the explosion resulted, injuring the plaintiff. Said the court: "The plaintiff could not close his eyes upon all that was going on around him or turn a deaf ear to the shouts of danger that went up from the defendant's manager and the bystanders around him, and yet hold the defendant liable because he did not actually see or hear the warning. . . . The instruction should have submitted the issue whether the plaintiff ought to have known the danger in which he was standing, in view of all the facts and circumstances, and not have been confined to what he actually knew, as was done by the one given."

In a New York case, it was shown that a taxidermist employed by the defendant company had poured a mixture of carbon disulphide, a disinfectant, into a bird case, containing electric wires. These wires produced a spark, which ignited the fumes and caused an explosion injuring another who was assisting him. The court held that apart from the statute, the plaintiff had an action at common law for damages.

Among other things, the court said: "It was the plaintiff's duty to assist at the service, and he had used the same material on other occasions, but did not know of the danger of using it in large quantity where there was an electric current, especially running through two twisted wires, the installation of which could be affected by the chemical, so as to permit a short circuit. It was the duty of the employer to know that, and to instruct as to the use of it and warn its agents and employees of the danger. But the plaintiff was committed to the work unwarned. There was a latent danger dependent upon a knowledge of scientific facts, which it was the duty of the employer to have and impart to its servants.

"Although plaintiff had served before in the use of the chemical, here entered a new factor, and as to that a new and more perilous service was introduced and the plaintiff should have been instructed, although he was new only to the increased risk of the service. . . . The manner of use was changed and a new element of danger introduced and yet the plaintiff was unwarned."

EMPLOYER MUST WARN WORKMAN

In this case, we find the employer being held liable to the employee for the injuries suffered because the employer failed to issue the warnings which his superior knowledge told him, or ought to have told him, should be given to the workman.

In a Missouri case, the workman had been given a can, supposedly empty, but which contained wood alcohol, and was told to solder the tip end of a spout. He attempted to carry out these orders, but when his blow torch came in contact with the alcohol it caused an explosion which caused the injuries complained of. The employer was held guilty of actionable negligence.

In a Massachusetts case, the superintendent of the employing company had a choice of safe and dangerous materials in cleaning out the interior of a boiler, but instructed the plaintiff to use naphtha. The latter attempted to do so, but the fumes came in contact with a lamp which he was carrying, resulting in the explosion, causing the injury complained of. The employer was held not liable, because the court was of the opinion that the superintendent was a fellow servant of the injured workman, and because the danger to which the workman was exposed was merely a transitory one, existing only on the single occasion when the injury was sustained, and due to no fault of plan or construction, or lack of repair, and no permanent defect or want of safety in the defendant's works or in the manner in which they had been ordinarily used.

In a Michigan case, the workman was directed by his employer to help put out a fire and was injured by the explosion of a barrel of paint containing benzine. Judgment was given in the lower court for the plaintiff, but this was reversed, the injuries received being regarded more as an accident than as the result of negligence. The court also held that keeping a barrel of paint on the premises was not negligence, although fire was not improbable. It was not in and of itself dangerous, nor was its presence or its use attended with danger, in the absence of the agency.

The court said: "This is not a case of insecure place or defective appliances, nor is it one where the servant was ordered into another branch of the ordinary service in which there were increased hazards. . . . The dangers ordinarily incident to a fire are obvious to persons of mature years. Employer and employees are equally conscious of such danger, and ordinarily equally skilled in the means employed to extinguish a fire. The work of extinguishment is usually attended with danger, and explosions are not uncommon. The law recognizes a fire as one of the perils which excuse acts otherwise illegal."

In a New York case, the employer directed his servant to thrust his hand into a waste pipe, whereby the hand and the arm of the servant were badly burned by a solution of potash which had been thrown into the pipe without the servant's knowledge and prior to his employment. The court held that the master's order was an assurance that it was safe for the employee to do so, and that the master was chargeable with negligence for not having exercised ordinary care before giving such assurance. The court also said that it was the employer's duty to furnish the servant from the outstart with a place to work in as reasonably safe and free from the risk of injury as the character of the employment would permit, or, before assigning him to work, to call his attention to such lurking dangers as in the exercise of ordinary prudence the former would have been able to discover. The duty was somewhat further intensified, in the opinion of the court, because of the youth and inexperience of the workman.

The employer must not come to the conclusion that these common law principles and decisions are by any means out of date and not applicable to cases to-day. The fact is, as was mentioned before, a great many of the States have not departed from the common law practice in the least particular. Then, in many of the States having workmen's compensation legislation, thousands of workmen are not covered by such legislation. This means that the common law still applies to them in case of injury. Keeping these points in mind will serve to benefit many employers.

EDITOR'S NOTE: This article is to be continued. Part II will deal with Workmen's Compensation Acts.

Thermo-Electric Pyrometers for Plant Use

BY A. O. ASEMAN

THE most widely used pyrometer for general metallurgical operations is the thermo-electric pyrometer. Its popularity is due in part to its cheapness, robustness, ease of observation, and availability for automatically making a permanent record. It can also be used over a wider range than any other form of pyrometer, giving readings of extreme accuracy from the boiling point of liquid air (— 193 deg. C.) to the melting point of palladium (1550 deg. C.).

In what follows, this pyrometer will be treated strictly from an industrial viewpoint. The following nomenclature for the various parts is now almost universally used. The two unlike wires giving rise to an e.m.f. when heated are known as a thermo-element or thermocouple, or simply couple. The couple, suitably insulated, complete with mounting and protecting tubes, is known as a fire-end. The galvanometer for measuring the e.m.f. developed is known as a millivoltmeter or potentiometer, and may be recording. If this instrument is graduated to read temperature direct, it is known as an indicator. The couple and galvanometer together are called a thermo-electric pyrometer or recording pyrometer as the case may be.

THERMOCOUPLES

Thermocouples are divided into two classes, namely, rare or noble metal, and base metal couples.

Of the rare metal class the Le Chatelier couple, composed of one wire (—) of pure platinum, and the other (+) of an alloy of 90 per cent platinum and 10 per cent rhodium, is the only one in general use. The two chief manufacturers of this couple are Johnson Matthey & Co. of London and Heraeus of Germany. Charles Engelhard of New York is now producing the Heraeus platinum in this country according to the original process. The Johnson Matthey & Co. platinum has a slightly higher thermo-electric power, but is not constant from year to year. The Heraeus platinum has maintained a constant calibration for many years, and is to be recommended of the two. It also exhibits less tendency to crystallize. The 90 Pt-10 Ir couple was popular for some time and is still used in places, as it has about 50 per cent higher thermo-electric power. Its use, however, is not to be recommended, as heating distils the iridium rapidly, thereby changing its calibration. Tests show a change of over 13 per cent from heating at 1100 deg. C. for eight hours.

Of the base metal couples there are a number in general use. These have a higher thermo-electric power, and are cheaper at first cost, but owing to their rapid deterioration, especially at the higher temperatures, it is often cheaper to use the more expensive rare metal couples. The higher thermo-electric power, however (being from four to six times that of the rare metal couples), is a decided advantage, as it permits the use of more robust indicating and recording instruments. The advantage of this for plant use is apparent.

Fig. 1 shows the temperature millivolt relation for the principal types of couples on the market to-day. The upper limit to which these couples can be used continuously is indicated by the termination of the curve. The chromel-alumel couples are useful at higher temperature than any other base metal couple, but are considerably more expensive. The temperature e.m.f. relation for most couples is rather complex, but can be closely approximated by the parabolic formula

$$E = a + bt + ct^2 \qquad (1)$$

or

$$E = ab + bt^2 \qquad (2)$$

In the case of most base metal couples, the curve approaches so closely to a straight line that for all practical purposes a linear equation holds

$$E = a + bt \qquad (3)$$

A couple is calibrated by observing the e.m.f. generated at one or more fixed points, and substituting these values in the corresponding formula and solving in the usual way. A more convenient method is to plot these points graphically and draw a smooth curve fitting all points.

As a general rule a couple should not be exposed directly to a high temperature, on account of its susceptibility to contaminating influences such as reducing gases, metallic vapors, silica, and other agents which al-

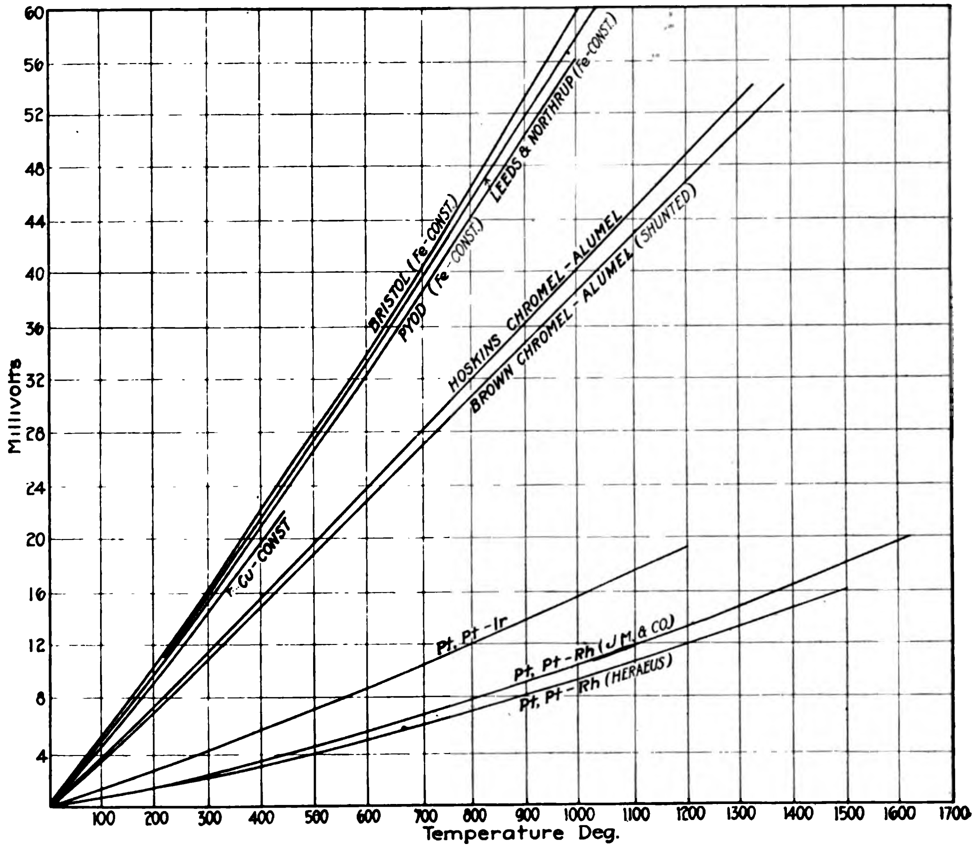


FIG. 1. TEMPERATURE-MILLIVOLT RELATION FOR THE PRINCIPAL TYPES OF COUPLES

ter its thermo-electric characteristics. This is taken care of by enclosing the couple in suitable protecting tubes. Often two protecting tubes are used, distinguished as primary and secondary. The primary protection is impervious to gas and may be either a glazed porcelain, silica or metal tube.

Porcelain is capable of standing a higher temperature, being used above 1200 deg. C. under constant temperature conditions. The porcelain available now has such a high temperature coefficient that it will not stand up under varying temperature. It has recently been announced that a pyrometer maker in this country has succeeded in making porcelain pyrometer tubes with a much lower coefficient of expansion, but up to the time of writing this we have been unable to try them out.

Silica can be used continuously up to 1100 deg. C. or for a short time to higher temperatures. At 1200 deg. C. or higher it devitrifies rapidly, becoming porous and losing its mechanical strength. Metal sheaths are usually of iron or steel, the properties of which are too well known to need special mention.

The secondary protection is used to give mechanical strength to the fire-end or to protect the primary from the action of corrosive vapors or metals. Zinc vapor is especially corrosive in porcelain. The materials most commonly used are fire clay, nickel chromium alloys, calorized steel or carborundum tubes.

The best manner of insulating the two wires is by means of a double bored insulating tube. This is very desirable when silica protecting tubes are used, as it is important that the wires (especially rare metal wires) do not come in contact with the silica.

It is desirable for plant use to mount the couple so that it, with its protecting tubes, will be firmly held together. This is usually done with suitable pipe fittings. Fig. 2 shows several forms of mountings with various accessories for portable and permanent use.

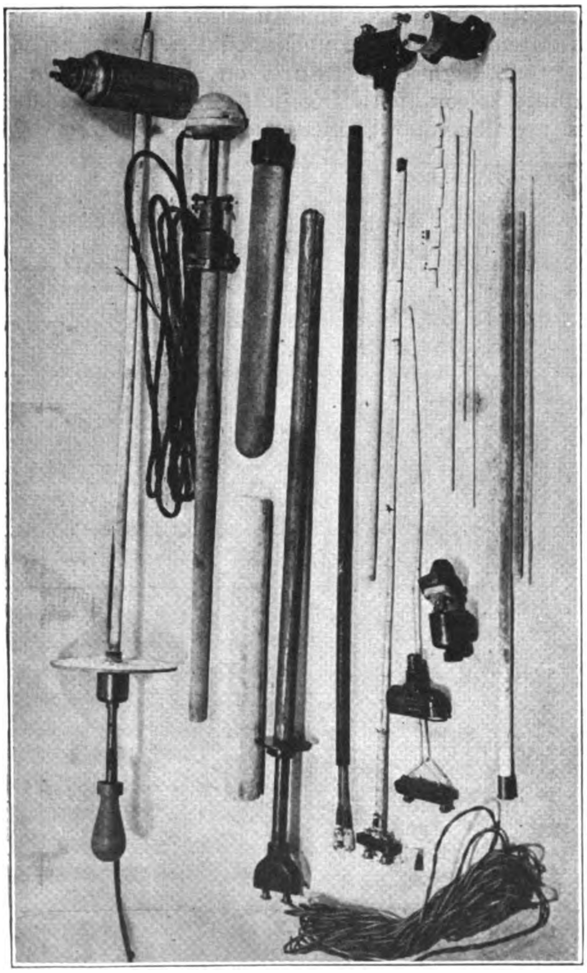


FIG. 2

Forms of portable and permanent mountings, primary and secondary protecting tubes, insulating tubes, cold junction extension wire, and water cooled cold junction devices.

GALVANOMETERS

The question of the instrument for reading the couple e.m.f. is one which deserves considerable thought. The tendency in instrument construction of the galvanometer type is to make as high a resistance as is consistent with making it sufficiently robust to stand up under plant usage. Instruments of this type are connected ammeter-like in series with the thermocouple. The thermo-electric current generated is small and is affected by any change in the resistance of the circuit. By using high-resistance instruments the change in the external circuit is a small part of the total resistance. Thus take the case of two galvanometers, one with an internal resistance of 5 ohms and one of 300 ohms, both calibrated to read correct for an external resistance of 2 ohms. Suppose that in each case the external resistance is increased by 0.8 ohm by changing the depth of immersion of the couple, or increasing the length of leads. The error due to the external resistance is equal to the resistance of the galvanometer plus the fixed external resistance, divided by the sum of the total resistance of the circuit.

$$\text{Then } \frac{300 + 2}{300 + 2 + 0.8} = 0.997 \text{ or } - 0.3 \text{ of 1 per cent}$$

$$\text{and } \frac{5 + 2}{5 + 2 + 0.8} = 0.897 \text{ or } - 10.3 \text{ per cent.}$$

A change of 0.8 ohm in the case of the 300-ohm instrument is quite negligible, while in the case of the 5-ohm instrument it is far from so, even for rough work. These are not exaggerated cases, but are constantly met with in everyday practice. It is quite evident, then, that the use of low-resistance instruments should be discouraged.

In an attempt to eliminate the effects of a variable external resistance, such instruments as the portable potentiometer and pyrovolter have been developed. The readings of these instruments are independent of the external resistance. They are excellent instruments and recommended for use wherever possible. They are, however, open to the objection that they do not give continuous indications, and require a certain skill to operate. Also they cannot conveniently be made recording. There is a recording potentiometer on the market, but it is more of a laboratory than plant instrument. The readings of a potentiometer cannot be relied on in extreme weather.

Special mention may be made of the Engelhard double suspension instrument and the Wilson-Maeulen unipivot instrument, both embodying features not found in ordinary galvanometer millivoltmeters. The former has no pivots, the moving coil being suspended by two delicate ribbons under tension. This has an extremely high resistance, but has the disadvantage of a shifting zero every time the position of the instrument is changed. It is also very susceptible to vibrations. The unipivot instrument has, as the name implies, only one pivot, which is at the center of gravity of the moving element. This is a very robust instrument, and is the only one on the market for portable use in which the pivot can be removed from the jewel while transporting from place to place. This is a valuable feature, as it has been our experience that these instruments are usually damaged while being ported about rather than when in use. It is evident that, although the weight of a moving element is small, when the entire weight is concentrated on a point there may be a pressure of several thousand pounds per square inch, in which case it does not require a very hard jolt to puncture the jewel. Of course most instruments are magnetically damped, but this only prevents rotation, and does not prevent the harmful sudden stresses on the jewels.

COLD JUNCTION

Attention should be called to the cold junction correction, since there is a notable tendency to neglect this important consideration. The e.m.f. developed by a couple depends on the difference in temperature between the hot and cold junctions, as well as the actual temperature of each. In calibrating a couple, therefore, the cold junction is maintained at some definite temperature, usually 0 deg. C. In practice it is ofttimes convenient to maintain the cold junction at a temperature other than that at which the couple has been calibrated, in which case the reading must be modified by a "cold junction correction." The correction is equal to the change in temperature multiplied by a factor.

$$\text{Cor.} = (t_1 - t_0)\, K \qquad (4)$$

t_1 = operating temperature of cold junction
t_0 = calibration temperature of cold junction (0 deg. C.)
K = factor depending on couple.

If the indications are obtained in millivolts, it is only necessary to add to the observed e.m.f. the value of the e.m.f. developed when the cold junction is at 0 deg. C. and the hot junction is at t_1 deg. If the indications are obtained in degrees, the correction must be made in degrees. For a Pt, Pt-Rh thermocouple, K, in formula (4) is 0.6 when hot junction is from 400 to 700 deg. and 0.5 when hot junction is between 700 and 1400 deg. C. In the case of base metal couples, the calibration curve of which is approximately a straight line, K is equal to 1.0.

A number of schemes and devices have appeared for keeping the cold junction temperature constant, or automatically compensating for same. One convenient method is by use of cold junction extension leads, whereby the junction can be removed to a region of more uniform temperature. These leads may or may not be of the same material as the couple, but they do have the same thermo-electric characteristics as the couple. In permanent installations one method is to bury the cold junction by driving a pipe pointed at one end 10 to 12 ft. in the ground, at which point the temperature remains constant throughout the year. Another plan is to water-cool the cold junction by means of running water. Still another is to lead the cold junction to a thermostatic controlled constant temperature box. There are numerous other devices, each having certain advantages and disadvantages. The methods described above merely keep the cold junction temperature constant. Those which compensate for a changing temperature are complicated, delicate and very likely to get out of order, so their use should be avoided.

Calibrations of thermocouples are spoken of as primary and secondary. Primary calibrations are made by noting the e.m.f. generated by a couple immersed in a pure substance, when at its melting point. Observations taken at regular time intervals show no change in temperature while the substance is melting. The melting point, which is very accurately known, serves as a fixed point at which couple e.m.f. can be read. Some of the commonly used fixed points are:

	deg. C.
Melting point of ice	0
Melting point of tin	232
Melting point of zinc	419
Melting point of salt (NaCl)	801

To calibrate a couple, then, it is necessary to observe the e.m.f. generated when the hot junction is exposed to the melting point temperatures of several of the above fixed points. A calibration curve can then be made by plotting the known melting temperatures as ordinates, and the corresponding e.m.f. in millivolts as abscissas, as in Fig. 1.

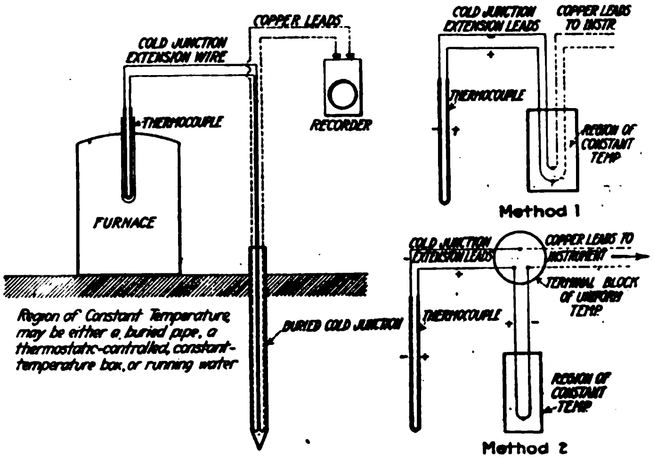

COPPER LEADS
COLD JUNCTION EXTENSION WIRE
THERMOCOUPLE
RECORDER
FURNACE
Region of Constant Temperature may be either a buried pipe, a thermostatic-controlled, constant-temperature box, or running water
BURIED COLD JUNCTION
COLD JUNCTION EXTENSION LEADS
COPPER LEADS TO INSTR
THERMOCOUPLE
REGION OF CONSTANT TEMP
Method 1
COLD JUNCTION EXTENSION LEADS
COPPER LEADS TO INSTRUMENT
TERMINAL BLOCK OF UNIFORM TEMP
THERMOCOUPLE
REGION OF CONSTANT TEMP
Method 2

FIG. 3. METHODS OF MAINTAINING COLD JUNCTION AT CONSTANT TEMPERATURE

By use of calibration curves similar to those shown in Fig. 1, it is possible to completely calibrate a couple, by simply taking a zinc point, and plotting this point with the corresponding curve for that couple. A curve drawn through the point and having the same shape as the standard curve will be the calibration of the couple.

The zinc point may be taken in the following manner: A crucible is made from a piece of 2-in. wrought iron pipe 8 to 10 in. long with a cap on one end. This is filled with "Horsehead" zinc and melted, and the couple, suitably protected, immersed in it. The whole is then allowed to cool, and readings made every half minute. The freezing point is taken when the couple indication does not change perceptibly over a period of 5 to 10 or more readings. It is best to protect the couple by a closed steel tube. Porcelain should never be directly exposed to molten or vaporized zinc.

Secondary calibrations are made by comparing the couple to another which has already been calibrated by primary calibration. This is best done by enclosing both couples, suitably insulated, in an iron pipe and heating the pipe in a furnace. Indications of both couples can be made on the same instrument by means of a double throw switch.

Generally speaking, it is better when possible to have calibrations made in a laboratory equipped for that purpose. All couples and instruments should be checked frequently.

Research Department,
New Jersey Zinc Co.

Manufacturing Plant of the Providence Gas Co.—II*

Description of the Installation and Operation of the New Water Gas and Producer Gas Plants at Sassafras Point—Water and Producer Gas Machinery and Apparatus, Measuring and Recording Instruments

BY WALTER M. RUSSELL

IN THE water gas plant three 11-ft. 6-in. U.G.I. standard carbureted water gas machines were installed. (Fig. 9.)

Air for blasting is provided individually for each machine, but by means of a manifold any one of the three blowers may serve the machines. In routine operations, one blower serves one machine only. The blowers were furnished by the Rateau-Battu-Smoot Co. and consist of standard Rateau steam turbines, each driving two birotor blowers, there being two impellers within a single casing acting in parallel, the inlet and discharge connections being connected in parallel with a single orifice in each case. The radial impeller blades are dovetailed into a heavy steel shaft. Volutes feed suction air to the impellers and after leaving the impellers the air enters the diffusion chamber, wherein discharge velocity is converted into pressure. The blower casing is parted on the horizontal center line. inlet and outlet nozzles being located in the lower half. These blowers operate at comparatively high speed—about 7500 r.p.m.—and, as the blower shaft is so designed as not to pass through its critical speed, the blowers may be stopped and started at frequent intervals, it being possible to bring them from rest to full speed in 10 sec. after having been heated up. Because of the high speed, great care had to be taken in designing the lubrication. The bearings are amply large and are provided with oil rings and water cooled chambers.

The steam expands in the stationary nozzles and drives the rotary element on a single row of buckets. The pressure of air is maintained by means of a constant pressure regulator, which acts directly on the steam, being adjusted for any given air pressure by a weight sliding on a lever arm. These turbo blowers have been highly satisfactory. At 140-lb. steam pressure, they have delivered 20,000 cu.ft. of air per min. through a 20-in. pipe with 36-in. pressure at the Venturi meter. Such apparatus must be given more care than is usually given to blast equipment for water gas sets.

The stack valve, up-and-down run valve, steam valve, secondary and primary blast gates are all handled by hydraulic valves. These hydraulic valves are controlled by a group of levers set together at a convenient place for the operator of the machine. The action of these valves is extremely smooth and satisfactory and has made the labor of operating the machines very light compared to the old fashioned manner of working.

During the period of blowing, the amount of secondary air required to make perfect combustion at the stack must constantly be increased, and to maintain this condition, an automatic device is made use of. This device consists of a small gas holder, which is filled during the blow by the air pressure from the main blast line. As this little holder gradually rises, it automatically increases the flow of air to the carbureter and, by means of simple adjustments, the right amount of air is admitted during each minute of the run to secure complete combustion of the carbon monoxide generated.

Venturi meters are used for measuring the flow of air to the generators during the blow. The pressure indication of the meters is transmitted to a water column on the gageboard of the machine, this column having a graduated scale, from which may be read the amount of air in cubic feet passing the fire per minute.

Venturi meters are also used for measuring the up-steam and down-steam used during the gas making period. The meters are equipped with indicating dials, which show directly the number of pounds of steam entering the fire per minute of run.

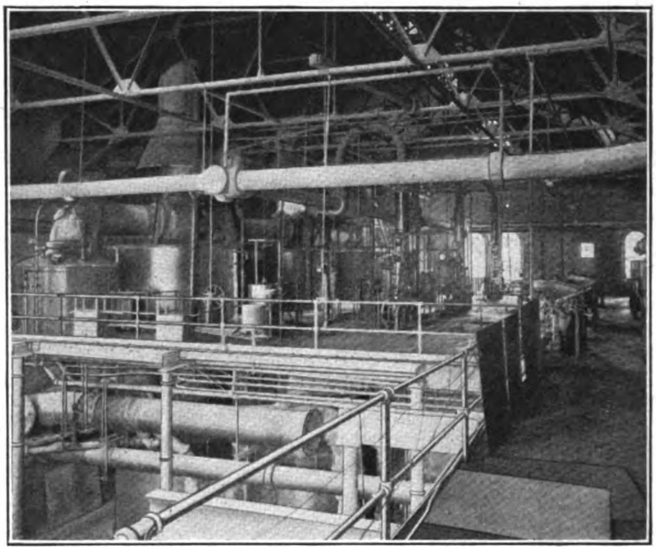


FIG. 9. GENERATOR HOUSE OPERATING FLOOR

To indicate the temperature at the top and bottom of the superheater, Bristol indicating pyrometers were originally installed. During the last year, on account of the poor oil and fuel which were obtainable, much more careful operation of the machines was demanded and Thwing recording pyrometers were installed, which made a record of the temperature at three points, namely: the middle of the carbureter and top and bottom of the superheater. These instruments are installed in a little dust-proof room just off the operating floor and have given great satisfaction.

A gageboard is provided for the use of the operator of the machines, located in a convenient place for his observation. On this board are placed gages showing the pressure of the blast air and, during the run, of the pressure under the grate and the pressure leaving the

---

*Read before the American Institute of Chemical Engineers, Cambridge, Mass., June 20, 1919. Part I published in CHEM. & MET. ENGNG., Vol. 21, No. 1, July 1, 1919, p. 34.

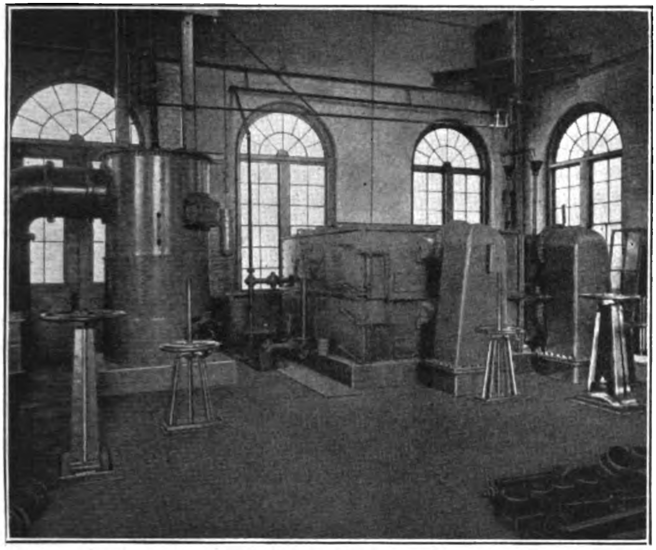


FIG. 10. TAR EXTRACTOR AND WASHER

machine. On the upper part of the gageboard is a gas maker's clock with a very conspicuous second hand, two dials, indicating, respectively, the amount of steam used on up-runs and down-runs, and a graduated gage glass for indicating the amount of air passing through the generator during the blow and a gage indicating the pressure of oil in the line going to the sprays. Back of the gageboard and in a convenient location is the battery of levers which control the operation of the hydraulic valves used in handling the various parts of the machine. There is also a meter for measuring the amount of oil admitted to the machine during each run. On the wall directly back of this bank of valves is an indicating pyrometer. It will be seen that great care has been taken to make the work of the operator convenient and easy, and it is possible to secure a very high degree of efficiency by such an arrangement.

The general design of these water gas machines does not depart from the standard American Lowe carbureted water gas plant as developed by the United Gas Improvement Co. and embodies those details of construction and operation which have proved themselves by many years of successful operation.

Coal or coke for use in the generators is delivered by means of chutes from the outside bins to trucks or buggies on the operating floor. These buggies hold about 3600 lb. of coal and are drawn over scales for weighing before discharging their contents into the generators.

The washer tar batter is a recent development of the United Gas Improvement Co. and it takes the place of the seal pot and tray scrubbers usually employed. It is set upon the operating floor at the side of the extended superheater with a short connector from it and consists of a steel plate shell with an internal divided flow dip pipe. Water, tar and foreign matter are removed by impingement on baffles as the gas passes through. In addition to its scrubbing action, the back pressure, during the gas-making period, is less with this type of apparatus, owing to the greatly increased perimeter of the 4-way pipe over that of a single dip pipe. This apparatus has given no trouble and has been uniformly successful in its operation.

Gas Main and Relief Holder—Leaving the seal pots, the gas enters a 36-in. outside overhead main, which carries the gas to the relief holder. This main is made of riveted steel pipe and is supported on steel trusses. The relief holder is of 500,000 cu.ft. capacity, in two lifts, in a steel tank, and is of the Bartlett Hayward standard style of construction.

Condensers—Gas is drawn by means of exhausters from the relief holder through a battery of two outdoor water tube condensers. These condensers are rectangular in form and have seven compartments, gas passing from one compartment to the next and being made to impinge upon the tubes by means of baffle plates. These condensers are constructed of cast iron, which permits the use of salt water from the bay. The temperature of the gas leaving the condensers is regulated by means of a Tagliabue control apparatus acting on the main water lines. Two pumps are provided for handling the salt water to the condensers, one of which is a spare. Both are centrifugal pumps, one being motor driven and the other operated by a steam turbine. From each compartment of the condensers a tar drain connects to a common tar main, which delivers tar and condensed water to the general drip system of the water gas plant.

Exhausters and Pumps—Two No. 10 Roots gas exhausters were brought from the South Station and set up in a new engine room. These exhausters have been driven at the rate of 400,000 cu.ft. of gas per hr. each, which is equal to the largest demand which has yet been placed upon the plant. During the past year, considerable trouble was experienced with the engines, owing to there being a rigid coupling between the exhauster and the engine, and this rigid coupling was replaced by rope couplings, which have given great satisfaction.

In the pump pit in the north end of the engine room are located seven Simplex pumps, which serve the general yard drips, circulating water to the submersion washer, washer tar batters, tar tanks, and oil supply from the oil tanks to the water gas machines.

Each pump is equipped with a constant pressure regulator and the oil pumps have, in addition, a by-pass relief valve, so that a very uniform pressure is maintained in the oil line.

Tar Extractor and Submersion Washer—After leaving the exhauster, the gas passes underground to the P. & A. house, where it first enters a submersion wash-

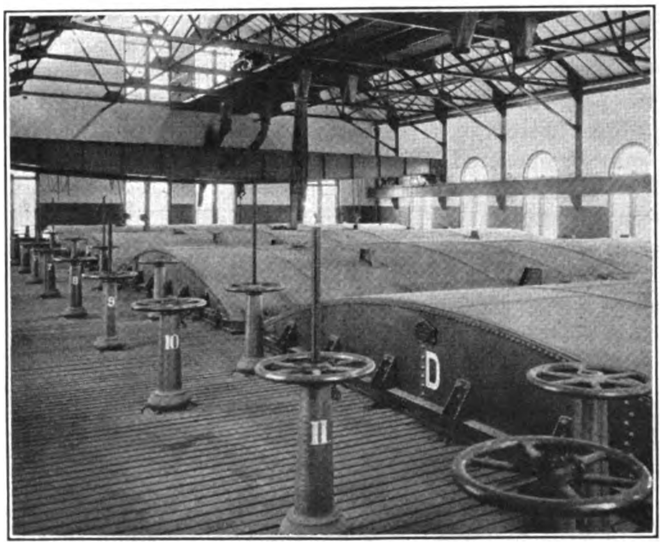


FIG. 11. WATER GAS PURIFIERS, SHOWING COVERS, BELT CONVEYOR AND CRANE

er supplied by the Western Gas Construction Co. This washer operates at a differential of about 2½-in. at full load and is fed with a small stream of warm water from the tar separators. This washer is built in two sections, one above the other. (Fig. 10.)

Following the submersion washer is a P. & A. tar extractor, designed and built particularly for water gas tar extraction by the Gas Machinery Co., Cleveland, Ohio. This extractor consists of a steel plate shell, housing a series of concentric slotted metal drums. This extractor operates at a differential of about 7-in. under full load. The capacity of the tar extractor plant is in the neighborhood of 10,000,000 cu.ft. per day and the plant has been satisfactory in every respect.

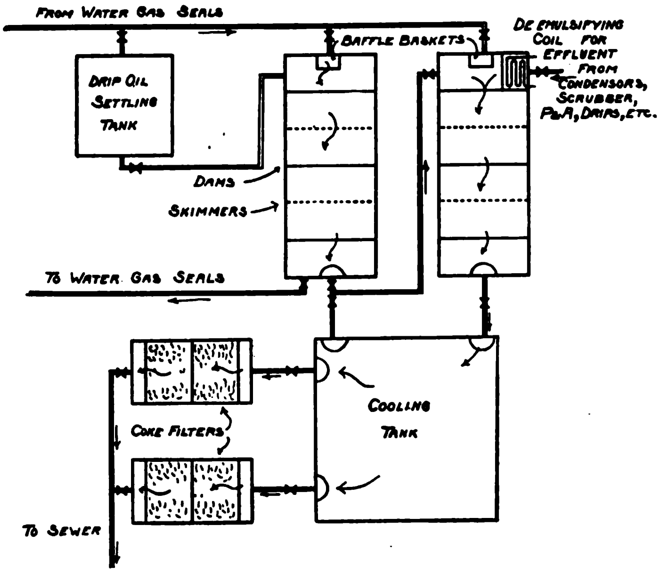


FIG. 12. DIAGRAM OF TAR SEPARATING SYSTEM

Purifiers—From the tar extraction apparatus, a 30-in. underground cast iron main runs to the purifying house—a distance of approximately 700 ft. There are four purifiers, 45 ft. by 25 ft. by 12 ft. (Fig. 11.) The four boxes are set in a line, connected on long sides by means of common partitions. The sides and bottoms of the boxes are constructed entirely of steel with riveted joints. The inlet and outlet connections are 24 in. in diameter. Each box is provided with two layers of tray supporting beams and two layers of oxide have been used, although provision was made for four tiers, if desired. The valve connections are so designed as to permit of passing the gas through the oxide from top to bottom or from bottom to top and also the boxes may be operated in forward or backward rotation.

To the bottom of each purifier are attached six oxide dumps, 20 in. in diameter, provided with self-sealing lids. The covers are of steel and are trunk shaped, reinforced by means of steel lattice girders located on the inside of the covers. The sides of the covers are formed of a heavy curved angle, which engages with an asbestos lute carried on the frame of the box. The covers are provided with holding-down clamps spaced about 40 in., center to center, designed to withstand a pressure of 36 in. of gas and any additional load due to tightness of the clamps.

The purifiers are supported upon steel beams, girders and "H" columns. For handling the purifier covers a traveling crane was provided operated by man hoists. In filling boxes, oxide is dumped from wagons or wheelbarrows into a bucket conveyor, which transfers the oxide to the top of the building, dumping into a belt conveyor, located at the bottom chord of roof truss and extending the entire length of the building. The conveyor was provided with a tripper for discharging the oxide to either of the four sets of filling spouts located above the boxes. This apparatus is motor driven.

Meters—From the purifying house, the gas passes underground to the meter house. When the meter house was built, space was provided for four meters, only one being originally installed for coal gas. At the time of constructing the water gas plant, a 12-ft. and a 14-ft. Tufts meter with Hinman drums were removed from the South Station and re-erected in the present meter house, the gas passing through these two meters in parallel, thence passing to the mixing mains, where the coal gas and water gas were brought together and sent to the distribution holders.

Storage Tanks—One 500,000-gal. steel plate tank was removed from the South Station and two others were erected on concrete foundations over piling. Two tanks have been used for the storage of water gas oil and one for water gas tar. These tanks give a gravity flow to the oil and tar pumps. Oil is received by barges from an oil depot on the other side of the bay and is pumped from the barges into the oil tank.

Tar Separators—The experience with tar separators has been somewhat unusual and has many points of interest. As originally laid out, the tar separating plant consisted of a reinforced concrete settling tank, 20 ft. by 15 ft. by 8 ft. deep, and two separating tanks, 60 ft. by 25 ft. by 7 ft. deep, followed by a cooling tank 52 ft. square and carrying about 6 ft. depth of liquor, the liquor finally passing through two coke filters and discharging into the bay. The tar and water from the generator house, after passing through the seal pots on the machines, first entered the settling tank and then passed into a common header, which also received the tar and condensation from the other parts of the water gas plant. It then passed in parallel through the two separating tanks, thence to the cooling tank and from here the water recirculated through the various pieces of apparatus. This apparatus was never very satisfactory and did not give complete separation of tar from water. In addition, settling took place, so

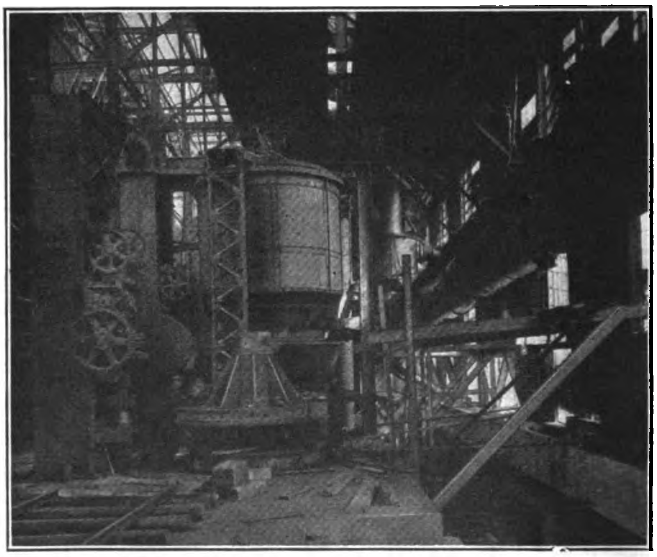


FIG. 13. GAS PRODUCERS AND ACCESSORIES

that the tanks cracked and leaked. In the summer of 1918, these tanks were waterproofed by means of a combination tar paper, pitch and sheet metal covering with a layer of concreting to hold and protect the waterproofing. This rendered the tanks waterproof and any further settlement is not feared. After studying the behavior of our tar and water emulsions, the following system was finally adopted: The first settling tank was abandoned, as apparently it served no useful purpose. The liquor from the wash boxes in the generator house was caused to pass into the first or right hand settling tank and double the original number of dams and baffles were provided, so that twice the separating effect was secured. The depth of liquor in the tanks was also increased about 15 per cent. The overflow from this tank, instead of going to the cooling pond, returned to the left hand or second separating tank.

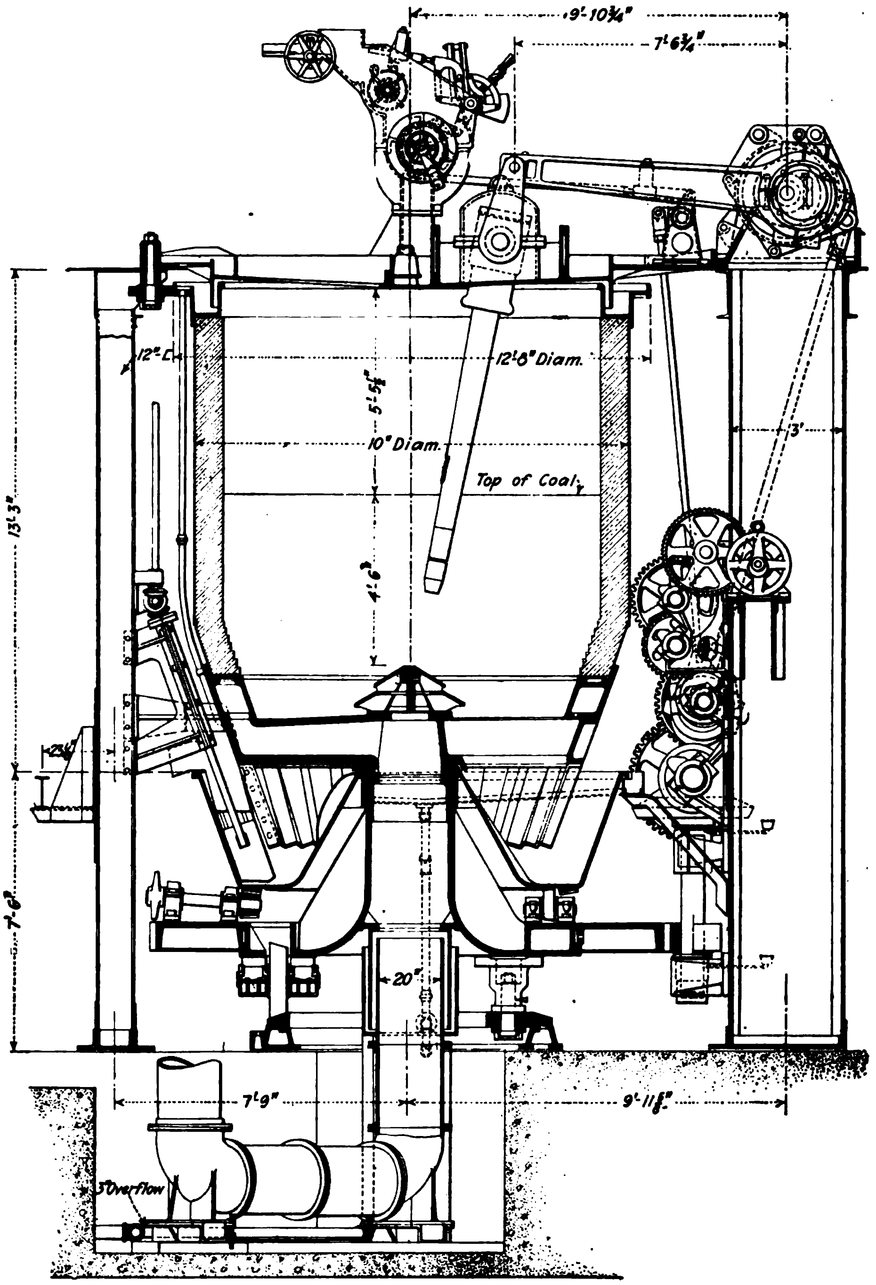


FIG. 14. HOT GAS MECHANICAL GENERATOR

The effluent from the tar extracting apparatus, condenser, exhauster house drips, etc., passed into a demulsifying chamber located at the entrance end of the second or left-hand separator, where it passed over a series of steam-heated pipe coils, thence discharging into the separator, where it mingled with the liquor coming from separating tank No. 1. The number of baffles and dams was also doubled in this second separator and the overflow from it went to the cooling tank and thence through the coke filters to the bay. The water for circulation through the wash box, etc., instead of being taken from the cooling tank, was taken from the end or separating tank No. 1. It will readily be seen that several improvements have been made. The length of travel has been doubled by placing the separating tanks in series instead of in parallel and, in addition to this, the separating effect in each tank has been doubled by doubling the number of baffles. Furthermore, inasmuch as the circulating water is now taken from No. 1 separating tank, the flow through the second separating tank is greatly diminished, as the volume of material to be handled is very much less than if the circulating water was taken from the outlet end of the whole system. The system as finally adopted has worked with great satisfaction, although, due to the forced employment of an inferior grade of oil during the past year, it has not been possible to secure water gas tar having a low moisture content, but the separation of tar from the circulating water is practically perfect.

The accompanying illustration (Fig. 12) shows the general layout of this apparatus. We are now using the first settling tank for storage of drip oil, etc., which we use in our boilers. The black solid lines show the flow of tar and water as now operated. The double lines show the original connections, which are not now in use. As is very well known, during the early part of the year 1918 there was a great shortage and demand for all products of ammonia. This fact was well recognized by the engineers of the gas company and influenced them in deciding upon by-product recovery producers. After the order had been given for the producers and before the details of the cleaning and ammonia extraction plant were worked out, this demand ceased and the original plans were not carried out. The plant as it is now, therefore, consists of by-product producers which may be operated either with or without by-product recovery and a set of apparatus for cleaning and cooling the gas, which has been considerably modified and simplified from the original design, although the plant could readily be converted for ammonia recovery, should it so be desired at any time in the future.

Gas Producers—The gas producers are five in number and were built by the Wellman-Seaver-Morgan Co. They are designed to produce gas from bituminous coal either with or without recovery of ammonia; or to produce gas from coke. Generally speaking, these producers are a modified form of the standard Hughes producer, the principal difference being in the maximum depth of fuel possible and the massive size of the machinery column, stirring mechanism, etc. (Fig. 13.)

In a casual observation, an engineer familiar with gas producers is immediately struck by the great height of this apparatus. The distance from the floor line to the top of the producer is 20 ft. 9 in.: from the top of the air inlet or tuyere in the lower part of the producer to the under side of the top, 10 ft., which would allow a fuel bed of 8 or 9 ft. in depth, including the ash and clinker zone. The inside diameter of the steel shell of the producer is 11 ft. 6 in. and there is a 9-in. firebrick lining, which reduces the diameter to 10 feet. (Fig. 14.)

When operating for plain gas production, the producer shell is rotated at a speed of one revolution in ten minutes. If it is desired to operate for by-product recovery, this speed will be cut in half. The ash pan is free to revolve independently of the shell but, owing to the presence of ashes in the pan, it revolves with the shell, due to the binding action of the wet ashes. In order to keep the ash bed and lowest zone of the producer in a free condition, it is arranged to have this ash pan take an intermittent retrograde movement with reference to the producer shell. This is secured by means of two trippers set at 180 deg. apart, which, by striking a stop, cause the ash pan to rotate for a few inches in a direction opposite to the rotation of the producer shell.

Coal is fed to the producer from an overhead coal bin by means of a gas-tight measuring feeder, which is operated by the motor driving the rest of the producer mechanism and can be adjusted through a wide range of speed in feeding. For stirring the fuel bed, a long poker is provided, which is dragged through the fire in a direction approximately at right angles to the direction of rotation. On No. 1 producer there are two pokers—a long and a short—which would be used in all the producers should they be operated for by-product recovery with a deep fuel bed. When using a deep fuel bed, the long poker stirs the zone just above the ashes and the short poker penetrates about 2 ft. below the top of the coal. The other producers are equipped with a single poker only, but the poker shaft is arranged to take the second short poker at any time desired in the future. (Fig. 15.)

These producers are blown with air saturated with steam, the air being furnished by Coppus steam turbine blowers at pressures running from 8 in. to 24 in., depending on the depth of fuel, depth of ash zone and other conditions. The exhaust steam from these blowers goes into the blast air and additional steam is also admitted under careful control, so that the temperature

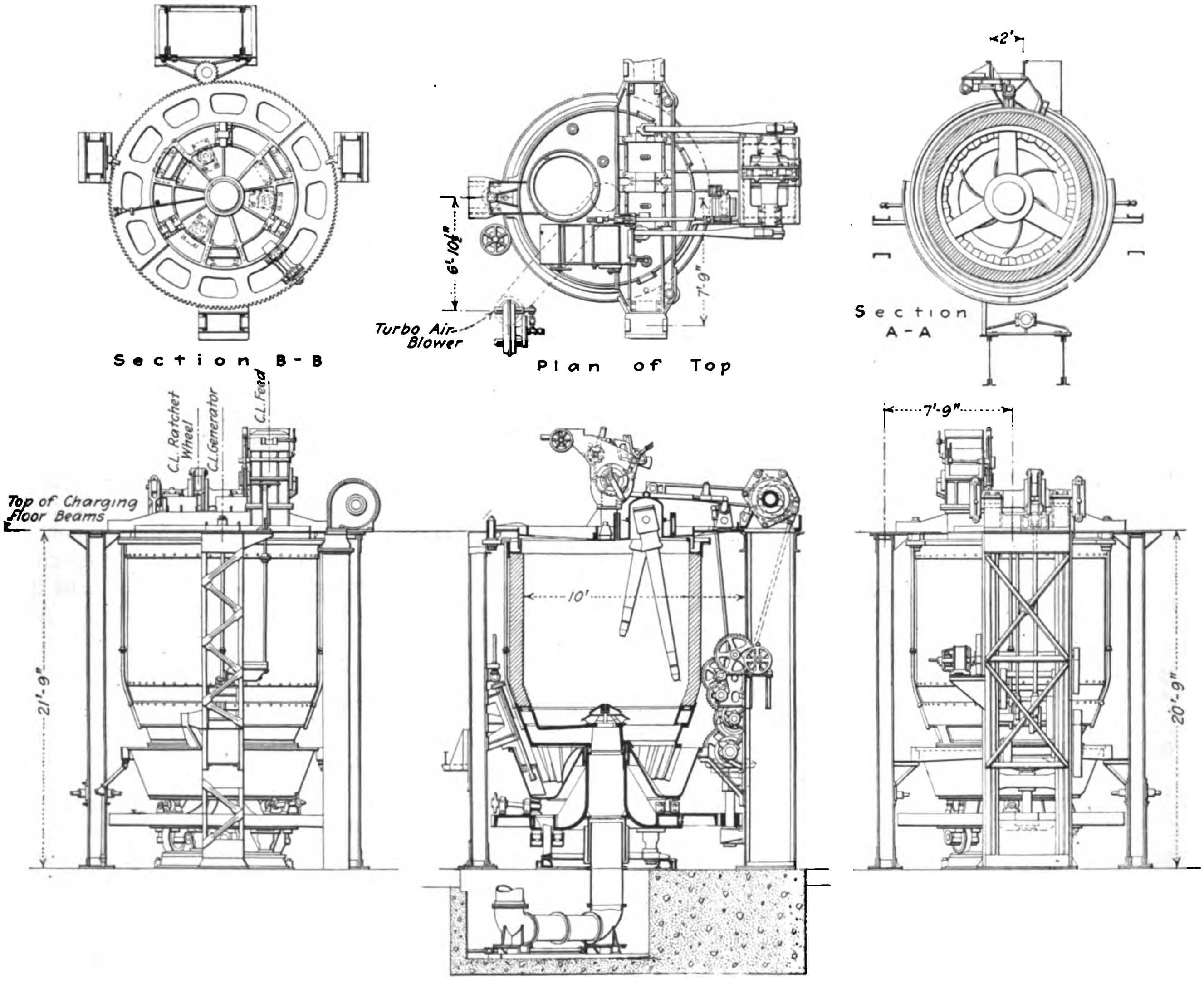


FIG. 15. BY-PRODUCT MECHANICAL GAS GENERATOR

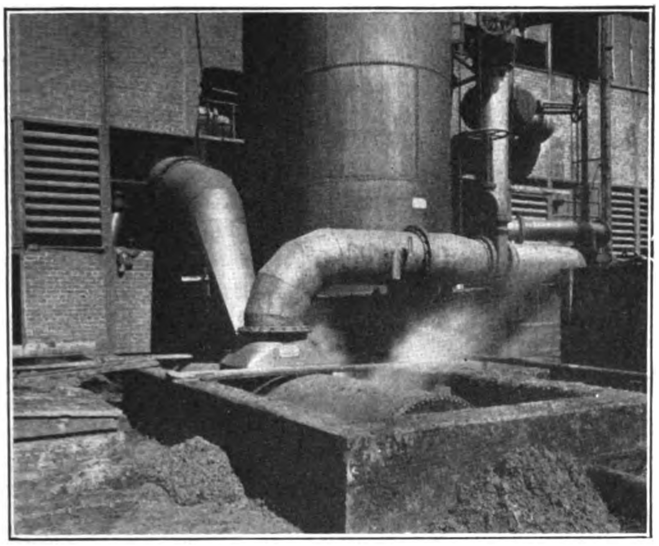


FIG. 16. BARBOTAGE AND WASHER COOLER

of the blast air is an indication of the amount of steam being used. This temperature may be 140 to 150 deg. F. more or less, depending upon the conditions, and this represents something like 1.2 lb. of steam per lb. of coal gasified.

Air is admitted to the center of the producer through a double headed tuyere, and also by means of a hollow spider the air is admitted at the sides of the producer in order to obtain an even distribution of air. The producer house is arranged for six producers, and should the plant operate for ammonia recovery, it is probable that six would be needed, five only being installed at the present time, which it is felt is ample for the heating of the forty coke ovens operating on 15-hr. coking time, running four producers with one idle for cleaning or repairs.

Roughly speaking, about 100 tons of bituminous coal of good quality must be gasified to heat the battery when in full operation. If ammonia recovery is practiced, probably not over 20 tons of coal will be gasified per producer per day. On the other hand, when operating with a shallow fuel bed without recovery of by-products, it is believed that three producers are entirely sufficent, inasmuch as 35 tons of coal have been successfully gasified in one producer in 24 hours.

In the first weeks of operation it was found that the heating value of the gas varied from 135 to 175 B.t.u., depending on depth of fuel, amount of steam, blast pressure, etc.

The oven battery is so designed that all or any part of the battery may be heated with producer gas, and a great deal of experimental work has been done in determining the range and capacity of the different parts of the producer gas plant by varying the number of ovens heated from one producer and also varying the coking time; thus demonstrating the extremely flexible arrangement of the combined producer gas and run of oven gas system for heating the coke ovens.

Gas Treatment—The preparation of the gas for use in the coke ovens requires removal of dust, pitch, tar and a large portion of the moisture and heat, the maximum desirable temperature at the outlet of the fuel gas holder being in the neighborhood of 100 deg. F. This problem was given to the Steere Engineering Co. of Detroit, who designed, built and installed all of the cleaning apparatus, acting also as engineers and erectors on the producer gas plant as a whole. The major portion of the apparatus was designed in line with the standard practice of the Steere Engineering Co. for clean producer gas plants, several improved and new features being introduced.

Dust Catcher—The gas leaving the producer has a temperature of 1100 to 1300 deg. F. and is laden with coal dust, soot and pitch. It first enters a dust catcher (one of which is provided for each producer), where a sharp and sudden change in the direction of the gas is caused, precipitating the dust to the bottom of the dust catcher. To accelerate this action, a heavy spray of hot water enters the dust catcher and strikes the inner cone, dropping thence to the bottom and washing out dust, etc., into a concrete separator.

Each dust catcher discharges its gas into a common collection main running the entire length of the battery of producers. In this main the gas is also heavily sprayed with hot water, the overflow running to the concrete decanter or separator. The gas issues from the collection main at a temperature of 165 to 175 deg. F.

Barbotage—From the collection main the gas enters the barbotage, which is a long rectangular steel box open at the bottom and sealed in the water in the decanter. (Fig. 16.) Inside of this box is another steel box with swinging sides, having serrated edges, the serrations dipping into the water. The gas comes into the inner box and is wire drawn over the surface of the water through the serrations. These swinging sides are balanced by weights and the differential through this apparatus remains the same when changes in the amount of gas passing occur, as, when the gas flow increases, the balanced vanes are blown outward, thereby opening a larger space for the gas to pass through in the serrations but maintaining the same relative action. On the other hand, if the gas flow diminishes, the swinging vanes come inward, decreasing the opening in the V-shaped serrations and again adjusting the wire-drawn effect to accommodate the amount of gas passing.

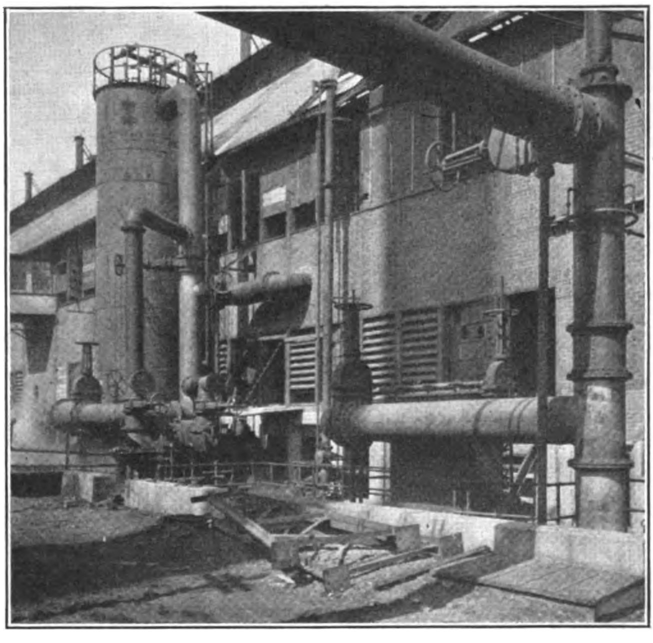


FIG. 17. WASHER COOLER, TAR BEATER, SEPARATOR AND DECANTER

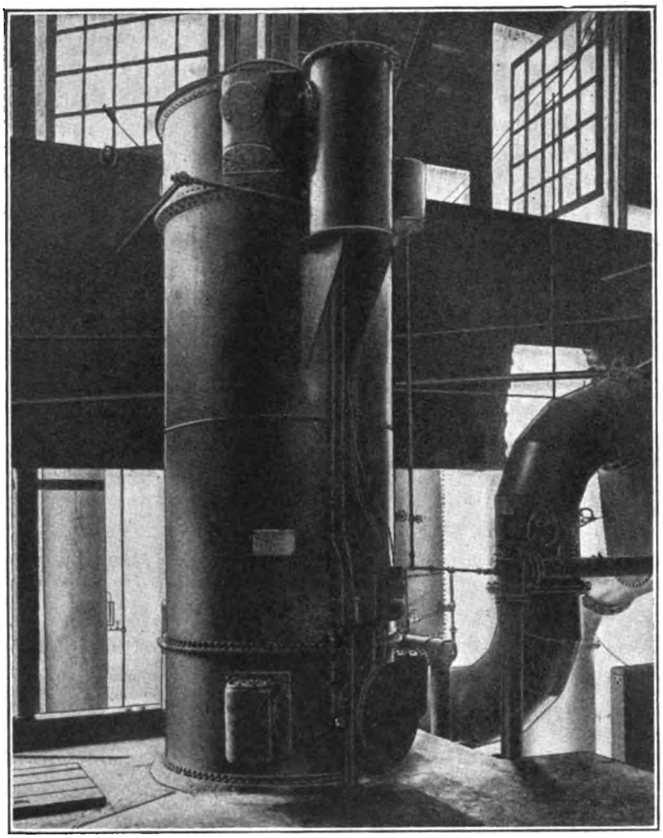


FIG. 18. IONIZER

The barbotage is equipped with sprays for use when necessary. At times dust accumulates on the surface of the water and interferes with the washing effect, and these sprays will drive this accumulation of dust down to the bottom of the decanter.

Washer Cooler—The gas has now been freed from excessive heat, dust and a large portion of the soot. Very little pitch has been removed, and this, together with the light and heavy tar and finely divided free carbon and dust, is still present. To remove a portion of these impurities and to prepare the gas for further treatment, the gas passes through a washer cooler, which is an upright steel shell filled with wooden grids, the gas passing up through the grids, which are heavily sprayed with cold water. (Fig. 17.) This is an exceedingly efficient method of cooling gas and also of removing impurities. The gas leaves the washer cooler at a temperature of about 105 deg. The water enters at about 95 deg. and is brought to a high temperature in passing through the washer cooler, which discharges into the general decanter which extends beneath all the cleaning apparatus.

Tar Batter and Ionizer—For the removal of finely divided pitch globules, heavy and light tars and very fine dust, a combination of centrifugal batting and electrical treatment is used. The gas first enters the tar batter, which is an apparatus something like an enclosed fan, which revolves at 1700 r.p.m. and is supplied with a spray of warm water. The centrifugal action on the gas serves to throw off all the large globules of pitch and heavy tar and the tar and pitch which is not thrown out and washed away by the spray is disintegrated into an extremely fine state. It then passes into the ionizer, which consists of a cylindrical shell containing a series of parallel tubes, each tube having at approximately its center a wire carrying electrical charge of alternating current with a potential of about 17,000 volts. Passing through this electrically charged atmosphere, the finely divided globules of tar and pitch are coagulated and coalesced and driven against the walls of the tubes running down into the bottom of the apparatus and going thence to the decanter. The jacket temperature of the ionizer is maintained at about 140 deg. F., which serves to keep the tar and pitch reasonably fluid, so that it will not build up on the tubes. The temperature of the gas passing through the ionizer in maintained at about 100 deg. F.

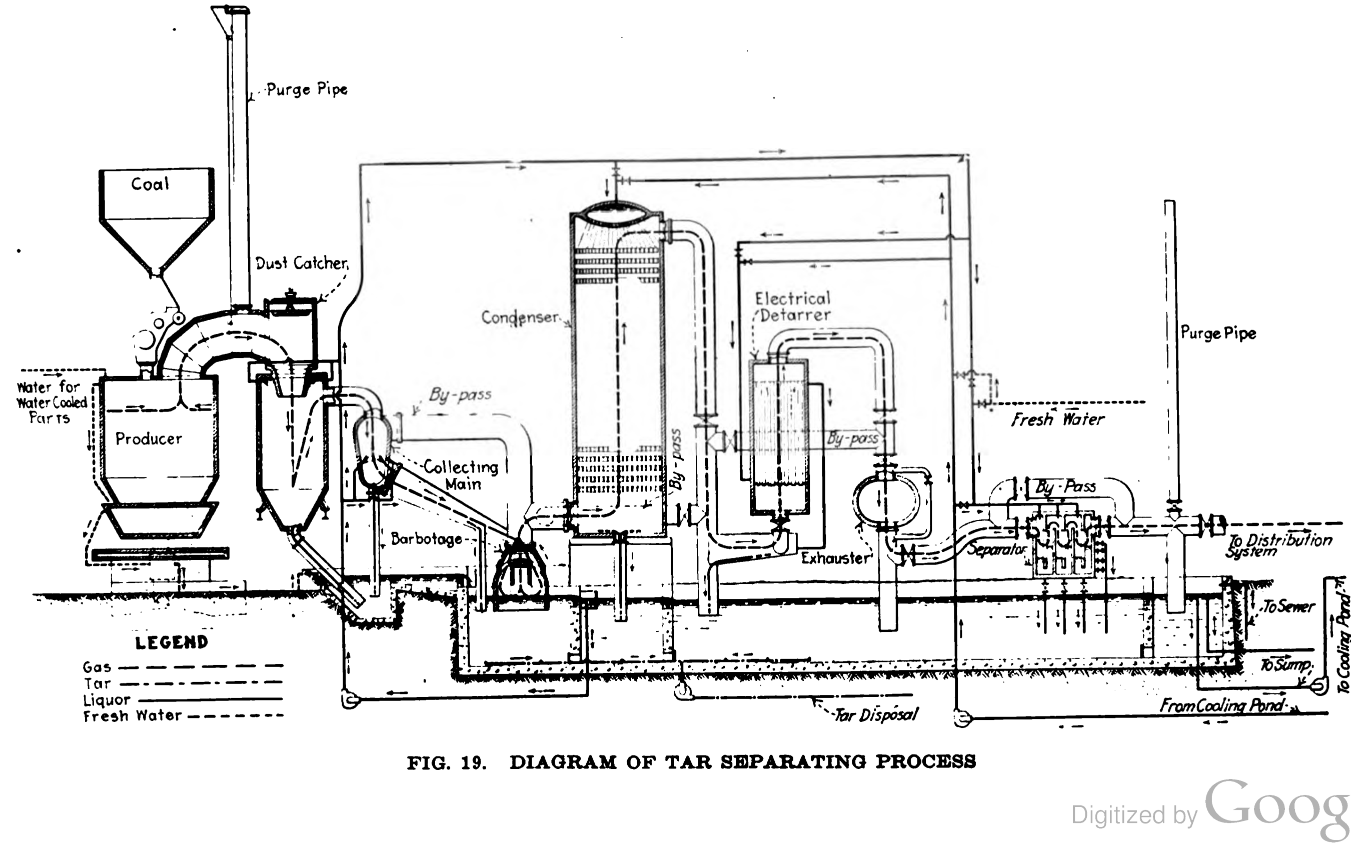

Purge Pipe
Coal
Dust Catcher
Water for Water Cooled Parts
Producer
By-pass
Collecting Main
Barbotage
Condenser
By-pass
Electrical Detarrer
By-pass
Exhauster
Fresh Water
By-Pass
Separator
Purge Pipe
To Distribution System
To Sewer
To Sump
To Cooling Pond
From Cooling Pond
Tar Disposal
LEGEND
Gas
Tar
Liquor
Fresh Water

FIG. 19. DIAGRAM OF TAR SEPARATING PROCESS

(Fig. 18.) After leaving the ionizer, the gas goes to two exhausters built by the Connersville Blower Co. and driven by vertical steam engines. These exhausters are automatically governed to maintain a very slight pressure just above the fire in the producers and force the gas through the rest of the cleaning apparatus over into the fuel gas holder. The temperature of the gas leaving the exhausters is about 105 deg. F.

Tar Separator—In the natural course of operating the plant, there are times when various portions of the plant must be by-passed for various reasons, which would permit some tar and dust to be present when leaving the exhausters. To take care of such emergency conditions or overloads, a tar separator was installed, which consists of a rectangular steel box, containing three sets of slotted plates with a backing plate behind each slot. The gas in passing through these knife edge slots is drawn into an exceedingly thin ribbon with high velocity, which, striking against the backing plate, is sharply deflected. This drawing action, combined with the sudden change of direction and further assisted by a spray of cold water which passes down the length of the slot, serves to remove traces of impurities which may be present at this point. After leaving the tar separator, the gas passes through a vertical pipe, where it rises for several feet, meeting a heavy spray of cold water, and thence passes directly to the fuel gas holder, which serves as a relief valve during the periods of reversal of the gas from one side of the coke oven to the other. All the seals on the cleaning apparatus discharge into a concrete decanter, which has several different compartments. In this decanter the tar and pitch separate from the water and suitable means are provided for the disposal of these materials. (Fig. 19.)

A set of centrifugal pumps is provided for handling the various circulations of hot, cold and warm water utilized. A suction pipe at the extreme end of the decanter takes the hot water to a pump, which sprays it in a cooling pond, where it is sufficiently cooled for reuse. The cold water from the cooling pond is drawn back and pumped over the washer cooler, tar separator and other places where a spray of cold water may be necessary. Hot water is secured by a suction line placed directly beneath the washer cooler, and hot water is used on the dust catcher, collection main and barbotage or other places where it may be temporarily desired.

The final results of this plant have not yet been definitely determined, but it has already demonstrated its ability to make absolutely clean gas within certain definite ranges, although the exact capacity of the plant as a whole has not been entirely demonstrated.

Minerals Relief Commission

The following procedure has been adopted in connection with claims arising under the Act of March 2, 1919, known as the Minerals Relief Act:

After the findings of the Minerals Relief Commission have been made, twenty days will be allowed claimant to file typewritten or printed brief based upon the record already made, making such comment on the Commission's findings as may be desired. At the end of 20 days the case will be finally submitted to the Secretary of the Interior. No new facts will be considered, those which have been submitted to the Commission only being given consideration. No oral argument will be heard.

Government Ownership of Water Power in Relation to Electrochemical Industry*

By F. A. J. FitzGerald

The examination of government ownership of hydro-electric developments in relation to electrochemical industry should cover a study of the effect of government ownership on the hydro-electric system considered as a productive industry in itself; the effect of this ownership on electrochemical industries which depend for their supply of electricity on the hydro-electric system; the effect of this ownership on the small user of electricity, such as the householder, and the nation at large.

Now, as regards the last consideration, it is not necessary to do more here than emphasize the fact that electrochemistry has become of such vast importance to the well-being of all the people that anything which affects its development adversely is bound to react on the nation as a whole. This was well brought out in a resolution of the board of directors recommended to and adopted by the American Electrochemical Society at its thirty-first general meeting in Detroit, May 3, 1917[1]. This report also emphasized the self-evident point that for the successful development of electrochemical industry an abundant supply of cheap electric energy is necessary. Therefore, in this report we may confine ourselves simply to a consideration of the effect of government ownership of hydro-electric systems considered as industrial undertakings.

ARGUMENTS BASED ON THEORY

Arguments in favor of government ownership of hydro-electric systems are based usually on theoretical grounds, because, with an exception to be noted later, we have no good example of this specific kind of government ownership from which to draw conclusions. It is pointed out that the chief item in the cost of water-power developments is the interest on the investment and that governments can accordingly construct and operate such systems much more cheaply than can private companies. The government can borrow money at a much lower rate than private individuals can, and, since it is not in the business for the sake of profit, it will establish suitable sinking funds to pay off all the investment, and eventually every one—the householder, the factory needing mechanical power, the railways, electrochemical industries—will get electric energy at an actual cost which is far below anything which we can now conceive. Furthermore, it is argued that, on account of governments being in a position to develop water powers much more cheaply than private individuals can, many of these which must inevitably go to waste if left to private initiative would be utilized, to the great benefit of the people.

In reply to these theoretical arguments certain examples of government ownership may be cited and must be given considerable weight, because they are examples of government ownership in actual practice and not merely deductive arguments based on theoretical considerations.

---

*An address delivered at the meeting of the American Electrochemical Society, New York City, April 3, 1919.

[1] *Transactions*, Am. Electrochemical Soc. (1917), XXXI, 16 *et seq.*

A classical example of government ownership is found in the case of the Chemin de fer de l'Ouest in France, which is well known to compare most unfavorably with the privately owned railways.

Perhaps, however, one of the best examples of the failure of government ownership is found in the British telegraph system. This was originally a private enterprise, but was taken over by the government in 1870. For the first two years, that is, during 1870 and 1871, the government made a small profit after paying interest on the debentures issued for the purchase of the system, but since that time the system has been run at a loss. In 1914 the Rt. Hon. Sir Charles Hobhouse, the Postmaster General, in a speech in the House of Commons, declared that in the last 40 years the British Government's expenditures on the telegraph system, not including interest on annual losses, or any provision for amortization, were in excess of receipts by $110,000,000, while if the interest on losses and amortization were charged the loss would be $200,000,000. The average annual operating loss for the years 1908 to 1915, inclusive, amounted to over $2,000,000, while for the same period the average loss, including interest and new money expended, amounted to more than $5,500,000. In 1916 a committee appointed by the government to investigate the possibility of saving money in government expenditures stated in regard to the telegraph system:

"The history of the telegraphs is most unsatisfactory. They were taken over in 1870 at a cost (including capital expenditures on extensions) of £10,129,687 in the anticipation that they would yield a profit to the State. After the second year of Post Office management the profit failed to cover interest on the capital outlay. Year by year the financial position has grown worse and worse. In recent years the loss upon working has not been less than £1,000,000 a year, and this loss includes nothing for interest due to the State upon the aggregate losses of previous years."

Manitoba's Experience With Telephones

Another example of government ownership that is, perhaps, more interesting than the British telegraph system because it is found on this continent and because it is an undertaking initiated much more recently is the telephone system of the Province of Manitoba, Canada. It has been the subject of a most valuable and interesting study by Prof. James Mavor of the University of Toronto, published in book form by Moffat, Yard & Co. of New York and the MacLean Publishing Co. of Toronto under the title "Government Telephones; The Experience of Manitoba, Canada."

The Manitoba government took over the telephones in 1907 and Professor Mavor's study covers the history of this experiment from that time till 1915. It would take too much space to review the book here, but we may quote one of the final conclusions amply borne out by Professor Mavor's masterly study:

"The entire history of the government telephone enterprise in Manitoba affords evidence of the most positive character against government ownership. Practically all of the defects which have emerged elsewhere in the management of industries by State officials have made their appearance in the case of the Manitoba telephones. The management has been ineconomical, the enterprise has been handicapped by political intrigue, the finances, mingled as they have been with the general finances of the Province, have been unsoundly administered from the beginning, and the obligations of the public have been enormously increased without adequate compensatory advantages.

"It is possible that only by repeated and costly failures such as the Manitoba government telephones will the public realize that the proper function of government is not the conduct of industries, but the impartial inspection of them under intelligent laws adapted to the character and conditions of the community and the country."[2]

These are typical examples where we might expect to find confirmation of the arguments advanced by advocates of government ownership, but this is lacking.

Hydro-Electric Commission of Ontario

As regards the government ownership of water powers we have fortunately one large-scale experiment in the case of the Hydro-Electric Commission of Ontario. This system is composed of several different parts throughout the Province of Ontario, Canada, and up to Oct. 31, 1917, involved a total capital expenditure of $36,976,900.99.[3]

The first important agitation looking toward government ownership of water powers in Ontario apparently began in 1900, when the Board of Trade of the City of Toronto applied to the Legislature for power to undertake the development and transmission of electricity from Niagara Falls.[4] This application was not favorably received, but the agitation in favor of public ownership continued and finally in January, 1906, the government appointed the Hydro-Electric Commission of Ontario. This Commission was given very great power, as may be seen from a study of the legislation which has been enacted and which may be found in a bluebook entitled "The Power Commission Act and the Hydro-Electric Railway Act," etc., published by A. T. Wilgress, Toronto, 1917. This bluebook will in future be referred to as "The Power Commission Act."

Originally the Hydro-Electric Commission was supposed to engage merely in the transmission and distribution of electric current; but it soon determined to undertake the generation of electricity on its own account, to construct its own hydro-electric plants, to compete with private companies, and there can be little doubt that it intends, if possible, to monopolize the hydro-electric systems of Ontario, judging from the statement of its chairman, Sir Adam Beck[5]

It would, of course, be impossible in this report to make anything approaching an adequate review of the results of the Hydro-Electric Commission's activities, but reference should be made to an extremely interesting study of these in a pamphlet entitled "Public Ownership and the Hydro-Electric Commission of Ontario," published by the MacLean Publishing Co., Ltd., Toronto, 1917. This contains a reprint of a series of articles by Professor James Mavor of the University of Toronto as well as certain other articles which appeared in the *Financial Post* of Canada. Future references to this will be abbreviated to "Public Ownership."

Twelve Objections to Government Ownership

In his examination of the Hydro-Electric Commission Professor Mavor considers twelve objections to government ownership and illustrates these from the history of the Ontario scheme. These objections may be briefly set forth as follows:

---

[2] "Government Telephones," by James Mavor, pp. 163-164.

[3] Hearings before the Committee on Water Powers of the House of Representatives, Sixty-fifth Congress, Part 3, p. 725 *et seq.*

[4] Ibid., p. 702.

[5] Hearings before the Committee on Water Power.

1. Increase in political power is one of the main motives in public ownership.
2. The conduct of industrial enterprises by government officials is not subject to inspection by impartial authorities.
3. The management of publicly owned enterprises is ineconomical.
4. In entering into industrial undertakings the government is apt to minimize the risks involved and to underestimate the amount of capital required.
5. Government officials are reluctant to provide for the continuity of the enterprise by setting aside adequate depreciation and reserve funds.
6. In governmental activities of this character there is a tendency to promote the illusion that profits inhere in industrial enterprises and to disregard the fact that, save in rare cases of adventitious profits, these are due to economy and skill in management.
7. The tendency to overman governmental enterprises of this character and the engagement of employees on political rather than technical grounds.
8. The tendency to fix the price of the governmental product at an arbitrary amount so as to induce the public to believe that the service is being rendered cheaply rather than at a rate determined by the technical conditions of the enterprise.
9. The tendency toward frequent crises in the management of the enterprise resulting from the fundamental unsoundness of the methods usually adopted.
10. The absence in governmental industrial enterprise of an experienced board of directors, its place being taken by a committee of politicians or the nominees of politicians.
11. A government preoccupied with industrial enterprises neglects its proper functions.
12. Government ownership tends to promote the illusion that politics and business are interchangeable terms.[6]

Effect of Government Ownership on Electrochemical Industry

It will be seen that this treatment of the subject of government ownership of power plants is a consideration thereof on the broad ground of public policy, but it may be well to look for a moment in more detail on the immediate effect on electrochemical industry.

The one great argument advanced by the advocates of government ownership is that of the low price of power. There can be no question that the prices charged for domestic use by the Hydro-Electric Commission are, at least in many cases, apparently much lower than could formerly be obtained. This apparently lower rate can be reached for various reasons. For example, the Hydro-Electric Commission does not pay taxes, as a private corporation must. Then by a peculiar application of the principle of "no discrimination" it is possible to charge an extremely small rate for domestic purposes. According to Sir Adam Beck: "The small user buys electricity at the same price as the large user. There is a standard rate in every community which applies whether you use 10 hp. or 10,000 hp. In the case of domestic users the small consumer buys it for less than the large consumer."[7]

When the actual rates charged domestic consumers are examined it is found that "no discrimination" means frequently that the consideration of the cost of the service is omitted. Thus on the Niagara Falls system it is found that the domestic rates for Niagara Falls, Toronto, Kitchener, Hamilton and London are the same, though the current is generated in Niagara Falls. Now, it is obvious that the cost of the current at a place like London, more than 100 miles from Niagara Falls, must be more than at Niagara Falls, where the current is generated, yet the price charged for it is the same. Then we have in Kitchener, about 80 miles distant, Hamilton 40 miles, Toronto 80 miles, the same price.[8]

In view of such an interpretation of "no discrimination" it is not surprising that a movement is now on foot among the consumers to agitate for a "uniform rate," which means that all customers of the Hydro-Electric Commission shall pay the same rate irrespective of their distance from the place where the power is generated.

It is obvious that the cost of power to consumers in the government-owned hydro-electric system is largely governed by their voting power and under such conditions electrochemical industries are bound to suffer, since they will certainly have to bear more than their fair share of the actual cost. It therefore follows that government ownership, so far as electrochemical industries are concerned, is not desirable.

Private Companies Compete Successfully With Government

Another point that should be noticed is that, in spite of the extremely favorable conditions, such as freedom from taxation, that the government-owned system enjoys, private companies are still able to compete successfully with the government enterprise.

No one will deny that there have been many reasons for complaining of the behavior of private companies, but the evils thus resulting can be remedied through government regulation based on the principle of seeing that justice is done to all; but when the government itself engages in business enterprises of this sort there is no hope of getting justice, and herein lies the greatest danger of the government ownership of water powers. This is admirably illustrated in the case of the Ontario Hydro-Electric Commission.

The Government of Ontario through the Commissioners of the Niagara Falls Victoria Park made a contract with the Electrical Development Co. of Ontario to rent water power to it and under Clause 16 of the agreement of Jan. 29, 1903, bound itself as follows:

"The Commissioners will not themselves engage in making use of the water to generate electric, pneumatic or other power excepting for the purposes of the Park."[9]

Remarkable Legislation

This agreement, of course, stood in the way of the Hydro-Electric Commission when it undertook to generate power from the Niagara River in 1916. Accordingly the following remarkable legislation is recorded in the Ontario Niagara Development Act:

"The exercise of the powers which may be conferred by or under the authority of this act or of any of them shall not be deemed to be making use of the waters of the Niagara River to generate electric or pneumatic power within the meaning of any stipulation or condition contained in any agreement entered into by the Commissioners for the Queen Victoria Niagara Falls Park." (6 Geo. V., ch. 29, cl. 7.)[10]

---

[6] "Public Ownership," pp. 15-48.

[7] "Hearings before the Committee on Water Power," p. 714.

[8] Tenth annual report of the Hydro-Electric Power Commission, Vol. II, p. 164 *et seq.*

[9] "Public Ownership," p. 7.

Naturally enough, the Electrical Development Co. was disposed to fight the government's repudiation of its agreement and therefore attempted to have the legality of its original contract passed on by the courts. This, however, proved to be impossible because the Hydro-Electric Commission had procured legislation of this character:

"Without the consent of the Attorney-General, no action shall be brought against the Commission or against any member thereof for anything done or omitted in the exercise of his office." (6 Edw. VII, c. 15, s. 21.)[11]

Since of the three men constituting the Hydro-Electric Commission one of them was the Attorney-General, it is not surprising that the fiat which would permit the testing of the legality of the Electrical Development Co.'s contract was refused.

The Hydro-Electric Commission also has extraordinary powers in regard to the making of regulations, as to the design, construction, protection, operation, maintenance and inspection of all electrical apparatus whatsoever used in the Province of Ontario, may order compliance with these and may order power supply cut off pending such compliance.[12]

A very serious situation was created by the Hydro-Electric Commission's activities during the war, and electrochemical industries were the chief sufferers. In spite of the serious shortage of power the Commission made every endeavor to extend the use of electric power in directions which would give it political power, with the result that electrochemical industries of great importance, not only to the prosecution of the war but to normal activities, were seriously hampered by having their power supply cut off.

RECAPITULATION

Whatever effect, whether good or evil, government ownership of water powers has on electrochemical industry will be transmitted to the nation at large.

Arguments advanced by advocates of government ownership are generally *a priori* and not based on actual experience.

Examples of governmental activities in various fields which can be undertaken by private enterprise offer evidence strongly against public ownership in such cases.

An examination of the only adequate example of government ownership of a hydro-electric system shows that all the evils have developed that are associated with governmental activities in fields other than those for which governments are instituted among men and that the largest individual users of electric energy, the electrochemical industries, will be the most direct sufferers therefrom.

ADDITIONAL NOTE

Since the above was written some more interesting and important information in regard to the Ontario Hydro-Electric Commission has become available in the shape of the report of Messrs. Clarkson & Sons, chartered accountants, on the accounts of the Commission. The government promised to have this investigation made in 1916[13], but the report was not apparently available to the public till March, 1918, and had evidently been kept from publication for a considerable time, as it only covers the period ended Oct. 31, 1917.

Apparently the report, in spite of its inadequate nature, is in accordance with what might be expected in a governmental enterprise of this kind. For example, the original hydro act provides in regard to payment on sinking fund account that "a municipal corporation . . . may be relieved by the Commission from payment of any sum on account of the sinking fund account for the first five years . . . the amounts . . . on sinking fund account shall be payable during the next ensuing thirty years."[14]

This has been interpreted as meaning that no municipality shall be charged any sinking fund for five years.[15] This ingenious distortion of the meaning of the act permits municipalities to conceal an actual loss on their enterprise.

It also appears that the report covers only the Provincial accounts, leaving out the systems of the municipalities which are controlled by the Commission.[16]

One remarkable charge shown by the report is a sum of $1,117,433.86 against the ratepayers of the Province, a large number of whom are in no way benefited by the Commission's enterprise. This money is for items such as "Investigations and reports on proposed municipal railways," "Demonstrations at exhibitions as to use of electricity on farms," "Engineering assistance and estimates to municipalities not under contract," etc.[17]

This charge should, of course, be against the municipalities included in the hydro combination or against such of these as were directly concerned; but had this been done the government's enterprise instead of showing the net surplus of $174,919.31, which it is made to do, would show a net deficit of $942,514.55.

Obviously this report shows that had the Commission kept "regular accounts" as required by the Act[18] "the results of an audit would show, and this report should show, that the operations have been carried on at considerably less than cost."[19]

Thus as time goes on the evidence which accumulates confirms what has already been observed in a large-scale experiment on government ownership of hydro-electric systems. It is only too obvious that those most directly affected will be the largest users of electric power, the electrochemical industries, and, looking at the subject from the broader aspect of the general good, that any partial or transient benefit derived from this encroachment of government upon industrial fields will be greatly overbalanced by permanent evil.

Decay of Woodpulp

At the spring meeting of the Technical Association of the Pulp and Paper Industry, attention was called to the annual loss of wood and pulp through decay, which has assumed such proportions as to present a serious economic problem. A resolution was adopted requesting Congress to appropriate $20,000 for the purpose of conducting investigations on the nature and habits of the fungi and bacteria causing the decay of pulp wood and woodpulp, so that methods could be devised for controlling and, if possible, preventing decay.

---

[10] "The Power Commission Act," p. 176.
[11] Ibid., p. 22.
[12] Ibid., pp. 41, 42.
[13] The *Financial Post*, Toronto, March 3, 1917.
[14] "The Power Commission Act," p. 30.
[15] The *Financial Post*, Toronto, March 15, 1919.
[16] Ibid.
[17] Ibid.
[18] "The Power Commission Act," p. 6.
[19] The *Financial Post*, Toronto, March 15, 1919.

A New Governor for Close Pressure Regulation of Gas Exhausters and Boosters

THE pressure regulation of rotary exhausters and boosters has occupied the attention of engineers off and on for more than 50 years. The "off and on" feature of the proceeding is due not only to the circumstance that requirements for closeness of regulation have become more stringent, but also to the change from throttling regulation to cut-off regulation. In order that we may appreciate the great difference between the two types of regulation, a brief review of the underlying principles will be made.

If a rotary exhauster works between given limits of intake and discharge pressure, and if the limits are to be kept constant, the work done by the engine per revolution is also constant.

Now let, of two engines, one be regulated by a throttle governor, and one by a cut-off governor. (See Fig. 1, which represents the indicator cards of both engines.) Then in the throttling regulation, any increase in speed of the engine will, for a given position of the governor, result in greater throttling loss and in less work per revolution. If the engine tries to slow down it is speeded up, and if it tries to speed up, it is immediately slowed down to its original speed. Conditions are, therefore, inherently stable.

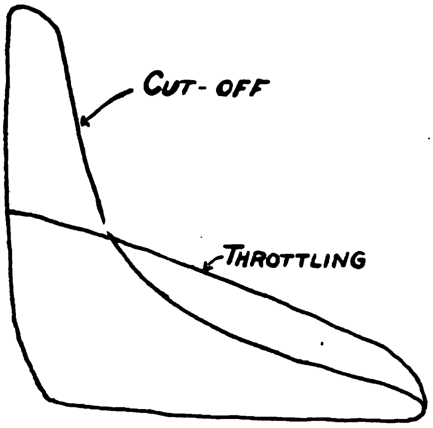


FIG. 1. INDICATOR CARDS, THROTTLE AND CUT-OFF GOVERNOR

It is quite different with cut-off regulation. If the engine speeds up, the work per revolution remains practically constant, and no large force is brought into play to bring the speed back to normal, unless that force comes from the engine governor.

Small self-regulating forces are brought into action, whenever a change of speed occurs, on account of friction of live steam and of exhaust steam through valves, ports and pipes, and on account of friction of the gas through pipes, tar extractors and the like. However, these forces are very, very small, and cannot be depended upon, except when changes in gas volume, steam pressure or back pressure are exceedingly slow and gradual.

While this fact has been known for quite some time in the governing of air compressors, it had, apparently, not been realized to the same extent in the governing of rotary blowers. The probable reason for this lack of application of correct principles of governing is the very general use of throttling regulation in connection with rotary exhausters; and that type of regulation is justified wherever the demand of the ammonia stills for exhaust steam exceeds the supply of exhaust steam coming from a high class steam engine with cut-off regulation. On the other hand, the requirements for closeness of regulation are very much closer in the governing of gas exhausters than they are in the case of air compressors. This statement is substantiated by the following facts: In air compressor practice, a pressure fluctuation of 5 lb. per sq.in. is not considered serious. If the air pressure be 85 lb. per sq.in., then 5 lb. is 5 per cent of the absolute pressure (85 plus 15 lb.). In gas exhausters, particularly in connection with by-product extraction, the pressure at the exhauster is to be kept constant within 5 mm. of water. Since atmospheric pressure roughly equals 10,000 mm. of water, the required closeness of regulation equals $5 \times 100 \div 10{,}000 = 0.05$ per cent. This means that in modern gas exhausters the regulation must be 100 times as close as it is in compressor practice.

Although it is very interesting to follow the development of exhauster governors in history, such study would lead altogether too far in the present article. For that reason, we will now describe the new pressure governor, calling attention, as we go, to the various features. The governor in question is made by the P. H. & F. M. Roots Co., of Connersville, Ind.

To be successful for close regulation, a pressure governor must instantly react upon the slightest change of pressure. Compliance with this requirement is much more essential in relay governing than in direct control governing, because the float is practically free from all vibratory forces so that the harmful effects of detention of the governor by friction appear with full measure. Even a slight amount of friction causes the pressure to vary rhythmically up and down over a considerable range. For that reason, sensitive pressure governors have always been made of the float type, and the Roots governor, shown in Fig. 2, is no exception to that rule. To avoid any and all solid friction, the governor is, for work on gas exhauster suction lines, buoyed up by means of an air chamber, and adjustment of suction is obtained by placing weights on the weight holder (4) below the tank. This arrangement necessitates an additional water seal in the center of the float, but the entire freedom from friction is worth the additional parts.

A very great difficulty with sensitive float governors is hunting, or surging. If the pressure departs from the normal value, the governor sets out to change the position of the valve gear. The adjustment continues not only to the point where the volume taken away by the exhauster equals the incoming volume, but beyond that point, because the pressure cannot be returned to the original value, unless the accumulated excess or deficiency of volume has been made up. When this end has been accomplished the governor is away out of the right position and the speed is away off. It takes a new, greater change of pressure in the opposite direction to bring the governor back to initial position, and the surges and vibrations become greater and greater. In the governor under consideration the difficulty is overcome by a temporary stability, which keeps the governor from following the influence of pressure too far.

To that end it is equipped with a stabilizing chamber which is partly filled with water. If the float tends to rise under the influence of less vacuum inside of it, the water in the stabilizing chamber is lifted, so that the float becomes heavier and resists being carried too far. It tends to come back to the original position. But it may be that the float would not settle in the original position, because steam pressure, back pressure or discharge pressure may have changed.

To enable the float to find its correct final position, the stabilizing chamber is made leaky on purpose, the extent of the leak being determined by an adjustable valve. The adjusting screw is visible at 3. With that valve wide open, the governor surges; with the valve dead shut, the governor does not maintain a constant pressure, but adjusts for different pressures in the gas suction line with different combinations of steam pressure, back pressure and discharge pressure. The best opening of the valve is easily found in practice.

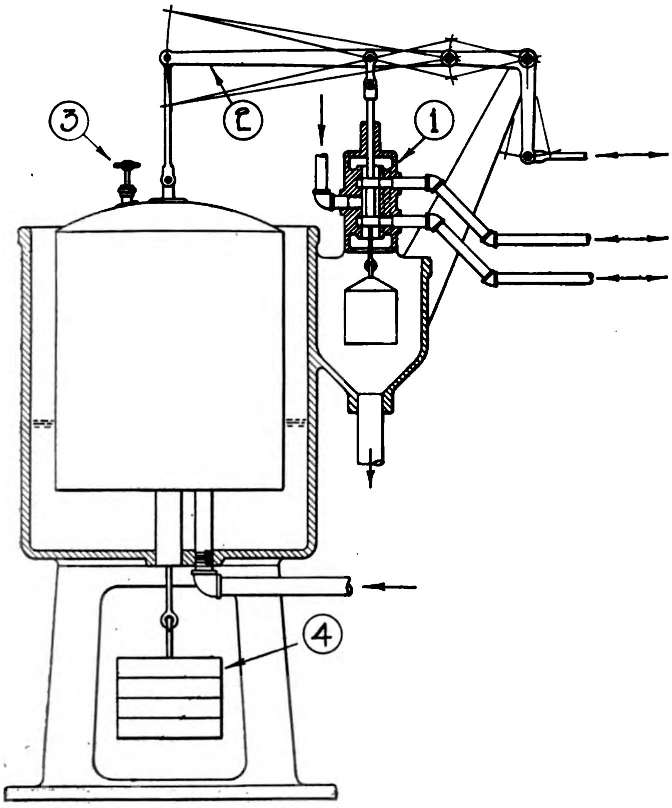


FIG. 2. ROOTS GOVERNOR

This temporary stability results in very fine regulation. If a disturbance of equilibrium occurs, the suction pressure departs slightly from the normal value, but a few oscillations with gradually decreasing amplitude soon bring the pressure back to the original value. In actual operation, this feature of the governor is easily tested by depressing the float away from its correct position and then letting go of it quite suddenly, or else by suddenly opening the by-pass from the discharge to suction on the exhauster. In either case the governor takes hold of the situation almost instantly.

The motion of the float is communicated to a vertical pilot valve 1 by means of light rods with very small pin joints which approach frictionless knife edges in their action. The pilot valve is made heavy on purpose, and is suspended from a floating lever, one end of which rests on a float, while the other end floats on the compensating return, the purpose of which is described below. In that manner, lost motion is eliminated and the slighest motion of the float is immediately transmitted to the pilot valve. The latter is made with an open-view discharge. Leaky pilot valves are a prolific source of trouble, because they require considerable travel of the governor before the pressure fluid acts upon the power cylinder. With closed discharge pipes, leaks are not discovered until the regulation becomes defective, and at that time almost every other part of the governing system is suspected, except the pilot valve. With an open discharge, a leak is plainly visible and is corrected before the regulation becomes defective. Too much emphasis can hardly be placed on this feature. In many relay governors, regulation gradually loses its precision due to increasing leakage of the pilot valve, and the engine or turbine operators are unable to locate the trouble, but if defective regulation is caused by a leaky pilot valve, the visible discharge shows it.

The compensating return of the pilot valve is a feature which is well known in governing practice. (See Trinks, "Governors, and the Governing of Prime Movers," Van Nostrand, 1919.)

Without such returning mechanism, the slightest displacement of the pilot valve causes the valve gear of the engine to be moved away continuously from its starting position, until the resulting speed change and pressure change moves the governor and displaces the pilot valve in the opposite direction. The governor surges or hunts, and never comes to rest, unless accidentally the valve gear is in correct position while the pilot valve is closed and when the governor is at rest.

To avoid this trouble, the compensating return was provided. Lever 2 is so connected to the valve gear that motion of the valve gear, induced by opening of the pilot valve, closes the latter. The valve gear cannot run away from the pilot valve, and all causes for hunting and surging are removed.

The closeness of regulation obtained with the Roots governor depends to a certain extent upon the power requirements of the engine valve gear. With releasing gear for Corliss or poppet valves, 3 mm. total fluctuation of suction pressure can be obtained, except during periods of excessively quick change in gas volume, steam pressure, back pressure or discharge pressure, when the pressure fluctuation may reach 10 to 15 mm. of water. With non-releasing valve gear, requiring power cylinders of great volume, the total pressure fluctuation will rise to 5 or 6 mm. of water, with peaks of 15 to 20 mm. for the first wave of excessively sudden disturbances.

The difference in closeness of regulation is caused by the greater requirements of pressure fluid in the power cylinder for adjusting non-releasing gears. If the pilot valve be made large, to admit oil or water in quick flow to the power cylinder, the frictional resistance of the pilot valve detains the governor. If the pilot valve be made small enough not to detain the governor, the flow of oil or water is insufficient to get quick action out of the power cylinder. To get the same closeness of regulation, both for non-releasing gear and for releasing gear, would require a much larger float for the former.

The Roots governor is made independently of exhauster contracts, and is furnished separately to improve the regulation of existing installations. Patents are pending, covering the principal features of the governing device. The best sizes of float, of buoyancy and stabilizing chambers, of leakage valve, of pilot valve, of pilot-valve weight and of sizes of ports are the final outcome of several years of close study and expensive experimental research.

Synopsis of Recent Chemical and Metallurgical Literature

Automatic Heating Furnaces.—Figs. 1 and 2 show sections of an automatic heat-treating furnace described by A. F. MITCHELL, metallurgical engineer, ordnance department, U. S. Steel Corporation, in the January, 1919, issue of the *Blast Furnace and Steel Plant*. Shells are fed into and through this furnace automatically, being rotated during their forward travel; while in the furnace they are supported upon cast iron plungers operating through the bottom of the furnace and are not only kept separated, but are held several inches above the floor, thus insuring perfectly uniform heat in the minimum time. The furnace itself is quite substantially built, as is evident from Fig. 3. It is heated by means of side gas burners, whose flame impinges directly upon a mass of refractory material shown in the cross-section. Careful regulation of the gas composition is important so that the non-oxidizing atmosphere within the furnace may be under complete control and so that there will be no fuel loss due to imperfect combustion. Indirect heating by reverberation has eliminated heavy metal losses by surface oxidation, and in conjunction with an enlarged heating chamber has insured a much better distribution of heat. It has also been completely demonstrated that money spent in adequate insulation of roof and side walls is soon recovered by the largely increased fuel efficiency.

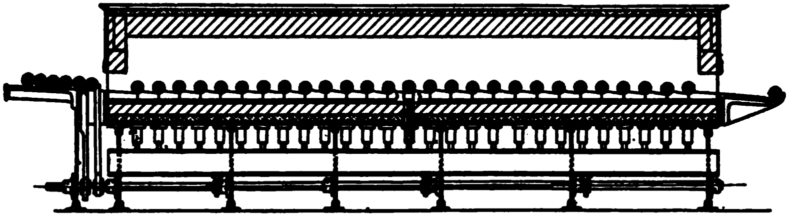


FIG. 1. LONGITUDINAL SECTION OF SHELL HEATING FURNACE

Solders for Aluminum.—Bureau of Standards circular No. 78 notes that aluminum is easily welded by oxy-gas processes, but ordinary soldering methods are somewhat difficult to apply. It is essential to prepare a clean, bright surface, which is then "tinned" by a high-melting solder with no flux. The Bureau recommends those compositions containing high percentages of zinc and aluminum selected from the suggested ranges given below:

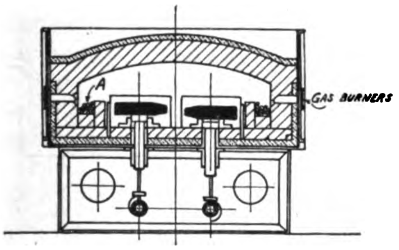


FIG. 2. CROSS-SECTION. A—REFRACTORY MATERIAL

Tin-zinc solders:	
Tin	Remainder
Zinc, per cent	15–50
Tin-zinc-aluminum solders:	
Tin	Remainder
Zinc, per cent	8–15
Aluminum, per cent	5–12

A perfect joint is very difficult and can be had only at relatively high temperature. When the two pieces are properly "tinned," any ordinary soft solder will join them together. However, any solder compound examined is electro-negative to aluminum, and consequently the joint must be carefully and continuously protected from corrosion by paint or varnish, otherwise it will rapidly disintegrate and the pieces fall apart.

Working Results of a Rennerfelt Electric Steel Furnace.—In the course of the discussion of a paper on the "Prospects of the Electric Steel Furnace in Sweden," by Mr. OTTO FRICK, Mr. I. RENNERFELT and Chief Engineer H. VON ECKERMANN put in the figures as actual results, with a 1¼ ton Rennerfelt furnace (arc-type), at Ljusne in Sweden, during the five days, from Nov. 21 to 25, 1916. According to them, 12 charges were dealt with in the furnace in question, the average net time per charge being 6 hr. 39 min. The average input was 1.27 metric tons, of which 19.5 per cent consisted of common Swedish gray pig iron, 6.5 per cent of billet croppings, 64.5 per cent of bar croppings, and 9.5 per cent of scrap. The additions were in eleven of the charges, ferromanganese and ferrosilicon, plus, in five charges, small doses of aluminum, some flux being added (Kiiruna ore = 1.8 per cent average of the charge) in every case, plus a small quantity of lime in one case. The average output (including scrap left) was 1236 metric tons per charge; hence the loss was 2.44 per cent. The scrap left over represented 10.12 per cent of the weight of the ingots and direct castings produced. The consumption of electrodes was 5.1 kg. (11.22 lb.) per metric ton (2.205 lb.), and the energy consumed 1010 kw.-hr. per metric tôn of steel (with 0.21 per cent carbon) produced. The work of the furnace was intermittent, hence the larger consumption of energy. With continuous working and producing steel with a carbon content of 1.20 per cent the chief engineer thought the average current consumption could be reduced to 800 kw.-hr. per ton of steel produced.—*Indian Engineering*, March 16, 1918, p. 149.

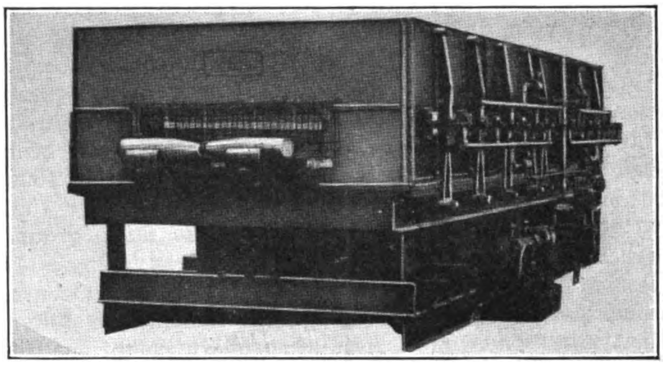


FIG. 3. AUTOMATIC HEATING FURNACE

Volatilization of Gold.—Literature contains many efforts to determine the volatility of gold, and from this contradictory evidence Sir THOMAS K. ROSE, in a paper presented before the Institution of Mining and Metallurgy, Mar. 20, 1919, deduces the following factors affecting volatilization: Time, temperature, amount of exposed surface, composition of bullion, composition of atmosphere, and movement of atmosphere. Preliminary experiments to harmonize the published information gave the most inconsistent results. The apparatus consisted of a quartz tube, gas heated, discharging into a condensing system. Microscopic examination of the condensed films showed them to consist of a multitude of spheres, of the order of 0.001 mm. diameter. Larger spheres sectioned, polished and etched gave polygonal crystalline grains, and no trace of concentric structure.

Considerable experimentation was necessary before the true blame for divergent experimental results was placed upon an inconstant atmosphere. When pure gold, or its alloys with silver or copper, are kept molten in a reducing or oxidizing atmosphere, the surface of the gold remains as a bright, motionless mirror. Under these circumstances the loss of gold is very small, being due to true volatilization. If there is a strong draught passing over the surface the loss by volatilization is naturally greater than in a still atmosphere, but is even then almost negligible at the ordinary temperatures of industrial furnaces.

Under all such conditions, however, gases are being absorbed by the metal. If the atmosphere above the gold now undergoes a change, say from an oxidizing to a reducing one, the quiet metal begins to effervesce due to the expulsion of certain of the occluded gases, possibly as new chemical combinations formed with the new atmospheric components.

Showers of globules of gold of all dimensions are thus thrown up, and the smaller sizes carried away by the current of gas. After a time, usually about 30 sec., if the reducing atmosphere is maintained, the action dies away, and the gold again becomes motionless and remains so until the reducing atmosphere is converted into an oxidizing one, when the same phenomena reappear. As molten metals occlude more hydrogen with increase of temperature, the greater losses observed at higher temperatures than at lower ones are readily explained. Other observed anomalies are due to the fact that pure gold does not occlude oxygen, hydrogen or nitrogen, while its alloys do.

It is evident that losses of really volatilized gold are extraordinarily small in industrial furnaces. Under constant atmospheric conditions, the author finds variations in weight between a loss of 0.052 to a gain of 0.017 per 1000. As a matter of fact the Royal Mint records a gross loss of between 0.2 to 0.25 per 1000, which is reduced to a net loss of 0.1 to 0.15 per 1000 after crediting the recovery from flue dust, ground crucibles and furnace bricks, ashes and sweepings. In less well conducted establishments the loss is of course much larger and may aggregate a half-million dollars per year. Under most rigid atmospheric conditions this can be enormously lessened, even granting the inevitable spirting loss which occurs when metal melted under charcoal is poured through air.

Maxima Magnetic Susceptibilities.—At the meeting of the Interallied Chemical Confederation held in Paris in April, 1919, Prof. HENRY LOUIS read a paper on the treatment of low-grade iron ores by magnetic concentration. The following table is abstracted from this paper (*Chimie et Industrie*, May, 1919).

MAXIMA MAGNETIC SUSCEPTIBILITIES PER VOL. C. G. S.

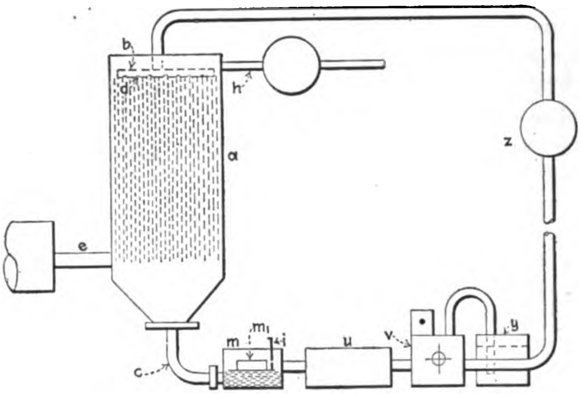
Ore	Locality	Susceptibility
Pure Soft Iron		400
Crystallized Pure Magnetite	Piemont	3.12
Magnetite	Hay Tor, Devonshire	1.44
Magnetite	Lake Champlain, U. S.	0.151
Iron Sulphide	Artificial	0.064
Red Hematite		0.00037
Brown Hematite		0.00016

Recent Chemical and Metallurgical Patents

British Patents

Extracting Ammonia From Gases.—Ammonia is extracted from hot gases, for example from furnace gases or gas producers, by a solution of a salt such as calcium chloride, or zinc chloride, possessing the property of forming a double compound with ammonia, which is delivered as a shower or spray by one or more distributing devices provided with spraying nozzles into a vessel through which the gases are caused to rise.

The apparatus comprises a vessel *a*, having a gas inlet *e* and a gas outlet *h*, and provided at the top with a liquid distributing box *b* fitted with spraying nozzles *d*. The vessel *a* is without internal projections, and is formed with a sloping bottom, so that solid matter, for example calcium carbonate, formed when the gas treated contains carbon dioxide, is washed out of the vessel. The heated liquid containing the absorbed ammonia leaves the vessel by a pipe *c* and enters a box *m*, where the dust and solid matter taken up from the gases, and which float on the solution, are separated by a scraper or filter, for example by a vertical plate *i*, a lateral opening M_1 being provided in the side of the box for the removal of the separated matter. The liquid then passes through a settling tank *u* to a tank *v* where it is treated with milk of lime to liberate the ammonia, and the residual solution is returned by a pump *z* to the vessel *a*. The ammonia may be absorbed in water in a vessel *y*, or a plant for producing an acid or an acid anhydride may be provided, the ammonia and acid or acid anhydride being led into a vessel to form a salt, for example ammonium nitrate may be formed from the ammonia, water vapor and nitric anhydride made by the electric arc process.



APPARATUS FOR EXTRACTING AMMONIA FROM GASES

When the hot gases contain tar in addition to carbon dioxide, a portion of the tar will be washed out of the gas and will mingle with the calcium carbonate, the mixture is removed in the separating box *m* and is burned for the recovery of the lime. The remainder of the tar passes off with the treated gas and may be separated by known means.

The hot solution before treatment to liberate the ammonia may be utilized for producing steam, or for heating water or other fluids.

In a modification, the hot gases are washed or scrubbed by a water spray in a separate vessel before entering the vessel *a*. The washing may be carried out to such a degree that the whole of the tar is removed from the gas. (British Patent No. 121,754—1918. E. L. PEASE, Darlington, Durnham. Feb. 26, 1918.)

Welding Different Metals to Steel or Iron.—Different metals are welded to steel or iron to form a composite ingot with a thin continuous sheet or strip of copper or other metal interposed between the welding surfaces, the sheet metal chosen being capable of alloying with a constituent of the metals to be welded. The metal to be welded, if of considerable thickness, may be in the form of thick sections alternating with thin sections. When a steel ingot is to be welded to another metal, the welding surfaces of the steel are first covered with tin or other easily fusible metal. (British Patent No. 122,365—1918. A. G. C. PITTEVIL, High Holborn, London. March 19, 1919.)

Refractory Bricks.—Separate portions of siliceous material, consisting chiefly of silica, one in relatively coarse powder and the other in a very finely divided condition, are mixed wet with animal or vegetable fiber, or both, to form a composition for molding. Both materials may be flint, chert stone, silica rock, quartz, sand, or stone rich in silica, calcined and the coarser is ground to 16 to 100 mesh. The fine material may or may not be calcined and will pass through a 250-mesh sieve. The fiber may be straw, chaff, peat, wool, hair or the like. The mixture of the two siliceous materials and fiber is mixed with water until the fiber is finely subdivided, molded, and the articles dried and fired at a temperature above 1500 deg. C. (British Patent No. 122,388—1918. C. H. SANKEY WILDCROFT, Chislehurst, Kent, and J. E. FOSTER, 48 Gilman St., Hanley, Stoke-on-Trent. March 26, 1919.)

Preparation of Dimethyl Sulphate.—Dimethyl sulphate is prepared by the reaction of sulphur trioxide on dimethyl ether in the presence of a solvent or diluent, preferably dimethyl sulphate itself. The sulphur trioxide used is preferably diluted with an indifferent gas; thus a current of air may be passed through hot fuming sulphuric acid and the resulting mixture of air and sulphur trioxide used, or the mixture of air, sulphur dioxide and sulphur trioxide resulting from the contact process of making sulphur trioxide may be used. The product of the reaction is treated either with ice or preferably with a reducing agent such as iron filings to destroy any sulphur trioxide present, and is purified by vacuum distillation. (British Patent No. 122,498—1918. W. N. HAWORTH and J. C. IRVINE, University, St. Andrews, Fifeshire. March 26, 1919.)

Sulphuryl Chloride.—A mixture of sulphur dioxide and chlorine in equimolecular proportions is passed over charcoal which acts as a catalyst to produce the combination with evolution of heat. The temperature should preferably be kept down to about 30 deg. C. (British Patent No. 122,516—1918. W. J. POPE, Holmesdale, Brooklands Avenue, Cambridge, March 26, 1919.)

Electrolytic Detinning Process.—An electrolyte for the recovery of tin from scrap and waste consists of a 7 to 10 per cent solution of caustic soda or potash in which is dissolved 1 per cent of stannous chloride. It is preferably heated to 180 deg. F. by a steam pipe. The scrap may first be washed in a caustic alkali or other solution to remove paper, etc., and placed in a perforated drum. (See British Patent No. 122,025—1918, for detailed description of this drum.) The drum is removed to the electrolytic vat and rotated or oscillated. After electrolysis, the drum is washed in water and the liquid is concentrated for restoration to the electrolyte. Two vats are preferably used alternately for washing and evaporating. The drum is next removed to a solder-recovery plant, and the residual scrap is discharged into baling presses. (British Patent No. 122,618—1918. Sir H. GREVILLE LODGE, Sir Harry's Road, Edgbaston; M. L. LANCASTER, Arden House, Stechford; C. M. WALTER, Lichfield Road, Four Oaks, and J. JACKSON, 70 Oxford Road, Moseley, all in Birmingham. March 26, 1919.)

Book Reviews

METALLURGY OF LEAD. By *H. O. Hofman*, Professor of Metallurgy, Massachusetts Institute of Technology and Harvard University. First Edition, 1918; XIV + 664 pages, 705 illustrations, 153 tables. New York: McGraw-Hill Book Company, Inc.

Professor Hofman's earlier work on "The Metallurgy of Lead and the Desilverization of Base Bullion" has not been revised since 1899. Originally published in 1892, it at best now represents details of practice since largely changed in modernized and recently-built American plants. The character of the ores treated has gradually changed due to the constant exhaustion of older mines and discovery of new, while the universal adoption of blast roasting is not only one phase of the trend toward economy of man power but has profoundly affected the entire lead-plant economy, from a metallurgical viewpoint.

Consequently this new book devotes 330 pages to a chapter on Blast-Furnace Smelting and 170 more to Desilverization of Bullion, a total of 500. Short chapters on smelting in the ore hearth, and in the reverberatory, on lead smelting, and on the properties of lead, its ores, compounds and alloys, make up the remainder of the book, exclusive of a comprehensive index.

In style the book follows the author's monumental "General Metallurgy" published a few years ago. Professor Hofman has been reviewing the pyrometallurgy of lead for "The Mineral Industry" annually since 1892, and the abstracts of contemporary literature contained in great numbers give both these books an encyclopædic value. However, the style is discontinuous and extremely difficult to read, giving the impression at times that the book is a compilation of dictated and card-indexed notes rather than that of a deliberate commentator on an intricate subject. Thus, there are illustrated and briefly described a large number of equilibrium diagrams of binary systems of compounds present in slags, mattes and other furnace products, but little indication how these studies may bear upon successful lead smelting. On the other hand a most excellent discussion of the chemistry of the blast-furnace is given on pages 339 to 345, which could readily have been expanded in many points and the connection between physicochemical theory and metallurgical practice pointed out at some length. Another contrast in style is unexpected of an author who uses the terms "smeltery," "wedge kiln," and puts a period after "per cent," yet uses through the running text chemical symbols of all metals and common compounds as well as such hybrids as "S-ides."

But enough of this side of the book. It is a monument to the extraordinary industry of the author, in that it contains a brief statement of all the scattered technical literature down to the time of going to press. Apparently the notable smelters and refineries in the United States were toured at intervals, and a lively correspondence maintained with their operators on technical matters, since the book abounds with observations culled from private notes and communications. Most notable is the excellent metallurgical and thermal balance sheet of blast-furnace practice at Herculaneum, Mo. Again, two very good general layouts of complete and modern plants are given, one of the Bunker Hill and Sullivan smelter at Kellogg, Idaho, and a second design by Mr. H. V. Croll. The latter is accompanied by a somewhat detailed estimate of the cost of construction—in fact, the author should be praised for uniformly including in his estimates the *quantities* of materials used, in honorable contradistinction to others who apparently think that $100 worth of brick are $100 worth of brick!

It would be difficult to justify criticism as to the relative amount of space devoted to various divisions of the subject. Thus Professor Hofman passes by mechanical roasters with a brief mention, to devote a great deal of space to the almost extinct hand-reverberatory. However, in his very thorough discussion of blast-roasting (well worthy of the attention it is given) he returns to the subject of mechanical roasting in an adequate manner.

The size of the book under discussion and the limits accorded a reviewer forbid any more than casual mention of the most striking features of the major chapter, and entirely preclude detailed analysis and discussion of the few controversial points left by our somewhat standardized American practice. Enough has been said, however, to indicate the grounds of the reviewer's opinion that the book will be of tremendous value to the studious workers in lead metallurgy, primarily because of its minute review of literature and present plant practice—as a compilation it is wonderful! On the other hand it will be as difficult a book to teach, having the same failing as has his earlier "General Metallurgy"; that is, in his mass of detail of various plants, appliances and citations, there are too few cases where the author leads the young student to form correct opinions by pointing out the principles underlying a design, or discussing the relative advantages for the particular problem in hand—as a critique it is a disappointment! Perhaps it is as difficult to write in a manner instructive at once to the expert and the student as it is to purchase a single suit wearable on all occasions!

E. E. THUM.

Personal

MR. LESTER E. ARMSTRONG has accepted a position as advisory engineer with the Powdered Coal Engineering & Equipment Co., Chicago, Ill. Prior to his service in the Air Branch of the Army, Mr. Armstrong was associated with Babcock & Wilcox.

The duPont scholarship for the year 1919-20 at the College of the City of New York, Department of Chemistry, has been awarded to **FELIX BRAUDE**.

MR. A. G. GREENAMYER, formerly of the Pittsburgh Crucible Steel Co., Pittsburgh, Pa., has accepted the position of metallurgist with the Donner Steel Co.

DR. GEORGE ELLERY HALE, director of the Mount Wilson Observatory and foreign secretary of the National Academy of Sciences, who has been for the last ten years a correspondent of the Academie des Sciences, Institut de France, has received the unusual honor of election as Associé Etranger, taking the place of Adolph von Baeyer, declared vacant by the Academy. The Foreign Associates are limited to twelve, and the high distinction has been held by only two Americans—Simon Newcomb and Alexander Agassiz. The National Research Council, upon the presentation and acceptance of Dr. Hale's resignation as its chairman and the election of James R. Angell as his successor, created and bestowed in perpetuity upon Dr. Hale the title of honorary chairman in recognition of his services to the National Research Council and to science and research by indefatigable efforts that have contributed so largely to the organization of science for the assistance of the Government during the war, and the augmentation of the resources of the United States through the newly intensive cultivation of research in the reconstruction and peace periods that follow.

DR. ARTHUR W. HIXSON has been appointed associate professor of chemical engineering at Columbia University. He entered on the duties of his new position July 1. Prof. Hixson was formerly associate professor of industrial chemistry and metallurgy at the University of Iowa, but for the last year he has been in the Ordnance Department at Washington.

MR. E. R. LEDERER, formerly superintendent of the Petroleum Refining Co. of Texas, has accepted a position with the Home Oil Refining Co. of Texas, Fort Worth, Tex., as general superintednent.

Leland Stanford, Jr., University has recently created a graduate department of mining and metallurgy which will be under the direction of **THEODORE J. HOOVER**. The chair of metallurgy will be held by **JAMES M. HYDE**.

MR. A. LUSSKIN is now research chemist with the International Oxygen Co., Newark, N. J. Mr. Lusskin was formerly on the chemical engineering staff of the Air Nitrates Corporation, Muscle Shoals, Ala.

DR. J. J. MORGAN, assistant professor of chemistry at Stevens Institute of Technology, Hoboken, N. J., has been appointed assistant professor of chemical engineering at Columbia University, New York City. Professor Morgan will enter on the work of his new position the coming September.

MAJOR STERLING TEMPLE has received his discharge from the Service at Edgewood Arsenal and is now research chemist for the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J.

COL. WILLIAM H. WALKER has been awarded the Distinguished Service Medal for exceptionally meritorious and conspicuous service. His extraordinary technical ability, untiring industry and great zeal enabled remarkable results to be achieved in the production division of the Chemical Warfare Service in the face of many obstacles.

DR. E. W. WASHBURN, acting chairman of the division of chemistry and chemical engineering, National Research Council, and **DR. CHARLES L. PARSONS**, chief chemist of the U. S. Bureau of Mines, sailed June 30 for London to attend the meeting of the International Chemical Union beginning July 15. Dr. Washburn will then go to Brussels as chairman of the American delegation of the International Chemical Union to attend meetings of the International Research Council and affiliated organizations beginning July 18.

MR. GEORGE J. YOUNG of the editorial staff of *Engineering and Mining Journal* has been transferred from New York City to San Francisco, where he will serve in the capacity of Western editor for the *Journal*.

Obituary

LORD RAYLEIGH (John Williams Strutt) died on June 30 in London. Born on Nov. 12, 1842, he was educated at Trinity College, Cambridge, where he was graduated as senior wrangler in 1865 and obtained the first Smith's prize of the year. From 1879 to 1884 he was Cavendish professor of experimental physics in Cambridge University, and in 1887 he accepted the post of professor of natural philosophy at the Royal Institution of Great Britain. He was awarded the Nobel Prize for physics in 1904. Many years ago his name became well known throughout Europe by his mathematical and physical papers written under the name of "J. W. Strutt." He used plain and usually homemade apparatus, the accessories being crude and rough, but essentials thoughtfully designed so as to insure in the most perfect manner the object in view. His work was the most productive in chemical physics, theory of gases, flow of liquids, photography, optics, color vision, wave theory, and in electric and magnetic problems of all kinds. It was said of him at the time of his election as Chancellor of Cambridge University in 1908 that "since the death of Lord Kelvin he is the most eminent chemist in Christendom."

MR. BOVERTON REDWOOD, one of the world's foremost authorities in the petroleum industry, died on June 6,

1919. Mr. Redwood was well known in this country as the author of many papers and books on petroleum and allied subjects and as a consultant of high standing on petroleum questions.

MR. WILLIAM G. SHARP, president of the United States Smelting, Refining & Mining Co. since its organization in 1916, died on July 1 at his home in Wenham, Mass.

MR. EUGENE WAUGH, president of the Waugh Chemical Corp., New York City, died recently at New Rochelle, following an operation. Mr. Waugh had been with the General Chemical Co. for fifteen years.

MR. WILLIAM THUM, superintendent of the electrolytic lead refinery of the United States Metals Refining Co., East Chicago, Ind., died on June 28, 1919, at his home in Hammond, Ind., after a brief illness from pneumonia. Mr. Thum was born in Germany in 1863 and received his early education there preparatory to the university. In 1879, however, he came to the United States with his father, F. A. Thum, who was a graduate mining engineer of the Clausthal School of Mines. In 1883 William Thum was made assistant superintedent of the electrolytic copper refining department of the Balbach Smelting & Refining Co., Newark, N. J., and there, in association with his father, he laid the foundation of electrolytic refining in the United States. At that time the Balbach company was using the Parkes process of lead refining, which was superseded by the electrolytic developments of Mr. Thum and his father. In 1904 Mr. Thum was made superintendent of the DeLamar Copper Refining Co., Chrome, N. J., and in 1906 he was sent to Chicago by the United States Metals Refining Co. in the capacity of superintendent of the electrolytic refinery at East Chicago, Ind. This was the first plant of its kind in the United States, although there were others at Trail, B. C., and at Newcastle-on-Tyne. It was at East Chicago that Mr. Thum developed a number of metallurgical processes, some of which he patented. These related to the recovery of bismuth, tellurium and antimony as by-products in electrolytic lead refining; other patents related to apparatus for use in the Pattersonizing process and electrolytic cell for parting Doré bullion. In addition to his attainments in metallurgy Mr. Thum showed unusual versatility in the arts. He painted in oils and water colors. He spoke French, German and English with equal fluency and read Latin with ease. His interest in outdoor life led him to acquire an extensive knowledge of birds and animals and took him to the hunting grounds of Maine. His sympathy with all good movements was shown during the war by his activity in Liberty Loan campaigns, and in the work of patriotic societies of the East Chicago-Hammond district of Indiana.

Current Market Reports

The Non-Ferrous Metal Market

Wednesday, July 9.—Prices have continued to rise during the past fortnight. Anticipation of orders from Central Powers has aided in strengthening the market.

Aluminum:—To be in equilibrium with the other metals on a pre-war basis, aluminum should decline; however, the holders are strong and can be induced to lower prices only to meet foreign competition. A price of 32c. lb. is quoted on 98-99 per cent ingot. Scrap has advanced: Cast 20-24c.; sheet, 21-24c., and clippings, 23-26c. Sheets, 18 gage and heavier, 41c., with some munition offerings at 36c. Powder, 5-ton lots, 45c.

Antimony:—Spot quotations continue at 8¾c., futures at 8½c., and small job lots at 8⅝c. It is believed that no immediate changes will occur.

Copper:—Small sales have been made on electrolytic spot at 19⅞c., casting at 19c., but lake July and August price is at 20c. September futures are reported at 20⅛c. The Government has liquidated its surplus of 114,000,000 lb.

The aggregate sales per week are large. Wire-drawers are the principal buyers, with brass foundrymen a close second. Japan has been buying heavily, the domestic output there last year having been lower than usual, 95,000 tons, of which 31,662 was exported. Only 1000 tons was imported from America due to the war embargo.

Copper sheets, hot-rolled	lb.	$28.50	—	......
Copper sheets, cold rolled	lb.	29.50	—	......
Copper bottoms	lb.	36.50	—	......
Copper rods	lb.	20.75	—	$21.00
Copper wire	lb.	21.50	—	21.75
High brass wire and sheets	lb.	23.75	—	......
High brass rods	lb.	22.25	—	......
Low brass wire and sheets	lb.	26.00	—	......
Low brass rods	lb.	16.75	—	......
Brazed brass tubing	lb.	34.75	—	......
Brazed bronze tubing	lb.	39.25	—	.....
Seamless copper tubing	lb.	33.00	—	......
Seamless bronze tubing	lb.	39.25	—	......
Seamless brass tubing	lb.	32.00	—	......
Scrap, heavy machinery comp		14¼	—	14½
Scrap, heavy and wire		14¼	—	14½
Scrap, light and bottoms		12½	—	13
Scrap, heavy, cut and crucible		15¼	—	15½
Scrap brass, heavy		8¼	—	8½
Scrap brass, casting		10¼	—	10½
Scrap brass, light		7¼	—	7½
Scrap, No. 1 clean brass turnings		7¾	—	8¼
Scrap, No. 1 comp. turnings		12¼	—	12½

Lead:—The price remains at 5.4c. for New York and 5.15c. at East St. Louis. Lead sheets cut, 8.5c. lb.

Tin:—It is difficult to gage the market. Spot tin is still quoted at prices around 68c. and 70c., but with importations of tin now free after Sept. 1 and ores that have been shipped on or after June 8 due to arrive here almost any day from South America, the chances are that before long we shall have prices which will come substantially nearer the figures now quoted for shipment tin, which is at about 52c. lb.

Zinc:—Spot spelter at East St. Louis is tending to advance from 7⅜ to 7½c. lb., New York, 7.4c.

OTHER METALS

Bismuth	lb.	$3.20	—	$3.65
Cadmium	lb.	1.40	—	......
Cobalt	lb.	2.50	—	3.50
Magnesium	lb.	1.75	—	2.10
Mercury	75 lb.	107.00	—	......
Nickel	lb.	.40	—	.45
Iridium	oz.	175.00	—	......
Palladium	oz.	115.00	—	120.00
Platinum	oz.	105.00	—	107.00
Silver	oz.	106.00	—	......

The Iron and Steel Market

Steel mill operations during the first half of July averaged between 65 and 70 per cent of capacity, against an average of about 60 per cent in June and a low point of approximately 50 per cent at the middle of May. As the increase in production has not altogether kept pace with the increase in buying that began just before the middle of May, it is clear that the recovery in the steel market is of very substantial character.

Demand has been distributed far from uniformly among the various lines of finished product, the divergence being due, of course, to varying conditions among the different classes of consumers consequent upon the war ending so recently. Some consumers were free buyers during the war, others have since become large buyers and still other prospective buyers, chiefly of the investment class, have not yet been ready to act.

Easily the most active line in finished steel products is oil country goods, the chief product of the lap weld departments of the pipe mills. This demand was rather heavy in the early months of the year and has lately been of such large volume as to fill the lap weld departments far ahead, a few mills being now sold up practically to the end of the year. Judged by all precedents, this demand is abnormally large, its expansion being due to the heavy demand for oil and oil products, the high market price and the increased number of wells necessary to produce the required output.

AUTOMOBILE TRADE ACTIVE

Next in point of activity is the automobile trade, which requires a somewhat larger tonnage of steel than at any time in the past. The automobile trade's demand is reflected most clearly in the sheet and cold drawn industries. Sheet mills are operating at more than 80 per cent of capacity, chiefly by reason of the demands of the automobile trade, as the demand for sheets for building purposes is relatively light. Makers of cold drawn shafting and screw stock are operating at about 80 per cent of capacity, against only about 60 per cent 30 days ago, and attribute the increase in their business chiefly to demand from the automobile trade. Their orders for bars are the best the bar mills are receiving.

Apart from these classes of demand, there is approximately a normal volume of demand for steel products from jobbers and from many classes of manufacturing consumers.

Where Demand Is Light

Where demand is light is among the railroads, the shipyards and investors generally who engage in large construction undertakings. There is practically no railroad demand at all. Even the 300,000 tons of rails it was reported several weeks ago the Railroad Administration would order, to round out its work for the year, have not appeared in the market. There would be no other buying of importance by the Railroad Administration, and the question is when the railroads will be placed in position to know what they will be justified in doing by way of improving their facilities, and what they will do when their position has been assured. While operating control of the roads is likely to be restored to the owners about Aug. 1, with the Government guarantee as to earnings running to the end of the year, the conditions under which the roads will operate in future, as to freight rates and the credit they can command, await action by Congress. The steel trade is of the impression that when railroad buying begins it will run rather to material needed for extensions of road and improvement of terminals than to freight cars.

Shipbuilding is at a greater rate than ever before, probably at between 600,000 and 700,000 tons deadweight per month, involving the consumption of 200,000 to 250,000 tons of steel, chiefly plates, per month, but the demands upon the mills are not in keeping, because stocks of steel at shipyards are being drawn upon.

Improvement in Construction Work

In construction work there is a steady improvement, as has been shown by the monthly returns of the Bridge Builders' and Structural Society and by various detached pieces of information as to contracts lately let or about to be let, but the pace even at this date is far below normal. It is true that much "building" activity is reported from practically all sections of the country, but this building runs largely to dwelling house construction and repair work generally. It is not, in general, the class of building that involves the consumption of much steel. As a matter of fact the activity is unfavorable to the steel industry rather than favorable, because with the supply of labor limited and also the supplies of some classes of material the facilities are pre-empted and construction work involving the use of large quantities of steel may be discouraged or postponed. The basic principle is that there is several years of work to be done, and the more pressing work will delay the less pressing. Thus dwelling houses will take precedence over bridges and skyscraper hotel and office buildings.

Steel Prices

The steel prices that became quotable March 21 are now firmly established. A considerable proportion of the steel bought in May and the fore part of June was at cut prices, though throughout the period the March 21 prices were regarded, generally speaking, as "the market." In the past few weeks this shading has been diminishing and it is now of very small proportions, except in plates, which present a relatively hopeless case, capacity being in excess of any easily conceivable demand. The condition has so changed that there is now no fear of any general decline in the market, while on the other hand, there are predictions in some quarters that advances in some lines will occur in the near future. It has now become generally known that the Steel Corporation some time ago adopted a definite policy, setting itself against any steel price advances, this year at least, and the question remaining is whether the independents in any line will be willing and able to engineer an advance of their own, thereby decreasing their prestige among buyers and forcing the Steel Corporation to choose between picking its customers or becoming badly oversold.

In view of the course the steel market has frequently pursued in the past, the maintenance of the general price level during May and June was remarkable. Many producers, including the Steel Corporation, refused absolutely to cut prices, being willing that mills disposed to cut should fill up. This forbearance was due in part to recognition of the fact that the business left on mill books at the conclusion of the war was very irregularly distributed, so that in the early months of the year some mills had been forced to operate at much lower rates than others. Thus it was only fair that mills should be allowed to buy their way into the market, while if the cuts had been met generally the sequel would simply have been additional cuts.

Pig Iron

The pig iron market has become well established. For several months consumers had been extremely desirous of reducing their stocks, and this policy was pursued to such length that many consumers found themselves with stocks far below normal, some with no stocks at all. A buying movement due partly to this situation and partly to increased consumptive requirements began the latter part of May. This movement appears now to have run its course, but it has left the furnaces that are in blast fairly well sold up, a few furnaces being sold up practically to the end of the year. The competition among districts has practically disappeared and prices in all districts are now on a fairly stable basis, with scarcely any prospect that prices will decline in the near future and a bare possibility that they will advance before the end of the year. An advance, however, is somewhat improbable so long as there are many idle furnaces, and should demand develop these furnaces would doubtless sell at the market, or a shade lower, to accumulate backlog business upon which to blow in.

The Chemical Market

New York, July 11, 1919.

Following the recent advance of *caustic soda* to \$3.30 per cwt., the United States Alkali Export Association last week raised the quotation on light 59 per cent *soda ash* to \$1.90.

Muriatic acid is gaining strength in the market although as yet no quotable change is announced. Dyestuff manufacturers are the principal buyers on the domestic end with Cuba still the main export source. Another acid which is feeling the general improvement is *sulphuric*, quantities of it being shipped to South America, whence emanates also a good inquiry for *caustic soda*.

Heavy sales of *potassium carbonate* are reported, most of it going for export. Stocks of *potassium prussiate*, yellow, are limited. The market is, therefore, advancing, now being 30-35c. per lb., an increase of 3c. *Sodium prussiate*, yellow, is in the same category. After a drop to 25c. per lb. last week, dearth of supply has brought the quotation up to the previous level of 35c.

Manufacturers are quoting *citric acid* at 98c. per lb., but find it difficult to deliver because of short stocks. Second hands are quoting \$1.05 per lb.

Oils—With no oil available in quantities until August, business in linseed oil is practically at a standstill. Quotations on raw linseed oil in carlots, August delivery, range from \$1.90 to \$2.14 per gal. against \$1.88-1.90 at last writing. Other vegetable oils are similarly situated, and the market is highly speculative. Thus far the signing of the peace terms has had no particular effect on trading, but as soon as Germany and Austria call for their badly needed fats further advances are to be expected.

Menhaden fish oils are reported scarce for spot but satisfactory for futures. The catches have been good, but the fish are lean and yield little oil. Soap, paint and varnish manufacturers are the heavy domestic users, while requests from Europe continue to be general. Winter pressed Menhaden is now quoted at \$1.20-\$1.25 per gal. against \$1.10 two weeks ago.

Coal-Tar Products—Among the crudes, benzol, solvent naphtha and toluol are the most active. Benzol continues in heavy request by rubber-tire manufacturers. Aniline oil is perhaps the strongest item among the intermediates. Nearly all manufacturers have their production for this month sold and few are offering any for sale during the remainder of the year. Japan is buying aniline oil and dimtheylaniline in quantities. Salicylic acid—which has been selling below the cost of production—has advanced five cents, to 25c. per lb. in carlots for the technical grade, owing to resale lots being off the market. It is rumored that the Government has on hand something like 20,000,000 lb. of phenol which will be turned over to two leading manufacturers for disposal at a figure officially fixed. Paratoluidine, H-acid and alpha-naphthylamine are having good sales, with ortho-toluidine and ortho-nitro-toluol beginning again to show signs of activity.

NAVAL STORES

After a drop from $1.10 per gal. to $1.02 during the past two weeks spirits of turpentine is again rising, at this writing having reached $1.05. The market in Savannah is also much firmer. The pale grades of rosins continue in active demand, with Holland the main customer. Owing to its increasing use in flotation processes, pine oil is in good demand. It is now quoted at 75c. per gal., a rise of 5c.

SHELLAC

The shellac market is still very much involved. Cables from Calcutta are from a week to ten days late and shed little light on the true situation. Dealers are merely endeavoring to supply regular customers and do not know when the situation will be relieved.

One dealer is quoting October-December delivery of TN at 90c., while another, on the same delivery, quotes 82c.; orange, superfine, 85c.; A.C. garnet, 72c.; and bleached, bone dry, 95c.

Chicago, July 9, 1919.

All heavy chemicals have either advanced a little or remained steady, coal-tar products show no fluctuation, vegetable oils are all up sharply and naval stores and flotation oils are in great demand at prices that seem very high.

Heavy Chemicals—Caustic soda and soda ash, under the impetus of fairly heavy export orders to the Orient, are held strictly at market figures; caustic being quoted at 3c. to 3½c. works for the solid and 4c. for the granulated, ash at 2c. Bleaching powder (*calcium hypochlorite*) is still quoted at 2c., with indications pointing to an advance.

Sulphuric acid is in heavy demand, sales being made at from $18 to $19 for 66-deg. Stocks of this staple are low, a combination of labor trouble and high cost of raw materials tending to curtail production. *Muriatic acid* is moving freely at $22; *nitric*, while not in such heavy demand, is quoted at 10½c. for 40-deg.

Potassium carbonate is expensive, because of dealers' stocks having been absorbed by export orders, the effect being a rise from the 13c. four weeks ago to 22c. to-day. *Sodium nitrate* is changing hands at $4.25 for crude, $5.60 for double refined, the demand being ordinary.

Coal-Tar Products—Slight tendency of prices to stiffen is the only notable feature in this line, 90% *Benzol* being quoted at 25c. to 26c., 100% at one cent higher. *Solvent naphtha* is quoted at 24c. and commercial *xylol* at 26c. No changes of moment are noted among the intermediates, trading in the entire coal tar line being merely normal.

Vegetable Oils—Recent sharp advances have had a decidedly repressive effect on sales, users limiting their purchases strictly to current requirements. All sales are of spot stock for immediate delivery, and it is unlikely that contracts will be placed at current figures.

Soya bean oil is quoted for July-August delivery in Chicago at 18c., cocoanut oil, Manila, at 18½c., sellers tanks. China wood oil brings 24c. in less than car lots, spots and futures being offered in cars at 21c. A definite shortage seems to have developed in corn oil, stocks going freely at 21c. and sellers tanks from the West at 19c. Cotton oil shows little activity at 25c. An advance in palm oil has been prevented by expected receipts from Europe, price being 17½c.

Flotation Oils, Naval Stores—Naval stores are rising in price so rapidly that sales are being curtailed. Pure steam distilled pine oil is now held at 85c. in carloads, 90c. for less, for .933 test, an advance of 7c.—68c. to 75c., in car lots. Pine tar oil remains at 36c.

Turpentine continues to fluctuate between $1.05 and $1.10, the demands of consumers being sufficiently heavy at this figure to prevent any early decline in price. Stocks are reported to be very short.

St. Louis, July 10, 1919.

Heavy Chemicals—An almost insatiate demand for *sulphuric acid* on the part of the fertilizer manufacturers and for *niter cake* on the part of the steel manufacturers is the outstanding development of the past two weeks. Producers report that while there are sufficient supplies of both these chemicals (and probably will be throughout the year) such large quantities are being contracted for and inquiries are so numerous that it is difficult to understand where the heavy tonnages sought for are going.

The only important price change reported since the last review is a 50c. per ton advance in 60% *sulphuric acid*, which is expected to result in an upward change in the price of other grades. An indication of the proportions the demand for 60% sulphuric is assuming may be had in the fact that one of the buyers in the local market has just closed a deal on the basis of an annual consumption of 15,000 tons as compared to a consumption of 4,000 tons last year, while another deal was consummated involving delivery of 100 tons monthly to a consumer who heretofore has required only 400 tons yearly. The 66%-grade is less active, the price still being $18 a ton. There is no change in the market for oleum.

Word is brought here by men in close touch with the fertilizer industry that because of the depletion of farm lands during the war, through the lack of commercial fertilizer, an unprecedented demand for fertilizers of all sorts now exists and is likely to continue for some time.

Muriatic Acid is not moving very rapidly, the price remaining at $22 a ton for 18%. *Sodium sulphate* (salt cake) has been selling heavily to glass manufacturers at $16.50 to $18, the former for heavy-tonnage contracts. There is more than a plentiful supply of salt cake, but from the manner in which the glass industry is preparing for the season to open on Aug. 15 it is expected present prices will remain firm.

Sodium bisulphate (niter cake): — Steel manufacturers who because of the scarcity of sulphuric acid during the war turned to niter cake for steel-pickling purposes will continue to use that chemical in place of sulphuric acid. Heavy sales of niter cake for this purpose are reported at $3.50 to $4 a ton. These prices are said to be representative of the market, the higher prices quoted in the last report representing special sales.

Nitric acid is the one item in the heavy chemical market in which a price decline is looked for. It is expected to occur on Aug. 1, due to the decline in the price of nitrate of soda. What little business is being done in this branch of the market is reported on the basis of 10c. to 10½c. per lb. for the 38° Baumé grade.

Zinc chloride is moving in heavy tonnage out of the local market to the tie-treating centers. As in the case of sulphuric acid, some consumers are trebling their normal requirements of zinc chloride. One transaction is reported involving a monthly shipment of 700,000 lb. to a plant which hitherto has been using only 140,000 lb. The price is firm at 4c. per lb. for the 50% solution, which is the only grade in which business on a large scale is being done here.

Zinc oxide was again quoted on formally by Mid-West producers, on July 1, but unlike previous announcements the list is subject to change without notice, though contracts are being written for delivery over the remainder of the year at the current prices, 8c. to 9c. per lb., according to lead sulphate content, in car lots; half a cent higher for smaller quantities.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET JULY 11, 1919

Acetic anhydride	lb.	$0.52	—	$0.60
Acetone	lb.	.14	—	.15½
Acid, acetic, 28 per cent	cwt.	2.50	—	3.00
Acetic, 56 per cent	cwt.	5.50	—	6.00
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00	—	14.00
Boric, crystals	lb.	.13¾	—	.14¼
Boric, powder	lb.	.13¾	—	.14¼
Hydrochloric, tech. 20 deg	cwt.	1.40	—	3.00
Hydrofluoric, 52 deg	lb.	.10	—	.11
Lactic, 44 per cent. tech	lb.	.11	—	.12
Lactic, 22 per cent. tech	lb.	.05	—	.06
Molybdic, C. P	lb.	4.50	—	5.50
Nitric, 40 deg	lb.	.07	—	.08
Nitric, 42 deg	lb.	.07	—	.08
Oxalic, crystals	lb.	.23	—	.28
Phosphoric, Ortho, 50 per cent. solution	lb.	.07½	—	.10
Picric	lb.	.30	—	.40
Pyrogallic, resublimed	lb.	2.30	—	2.55
Sulphuric, 60 deg., tank cars	ton	11.00	—	13.00
Sulphuric, 60 deg., drums	ton	17.00	—	.....
Sulphuric, 60 deg., carboys	ton	20.00	—	.....
Sulphuric, 66 deg., tank cars	ton	16.00	—	18.00
Sulphuric, 66 deg., drums	ton	21.00	—	.....
Sulphuric, 66 deg., carboys	ton	25.00	—	.....
Sulphuric, fuming, 20 per cent.(oleum) tank cars	ton	20.00	—	22.00
Sulphuric, fuming, 20 per cent.(oleum) drums	ton	25.00	—	.....
Sulphuric, fuming, 20 per cent.(oleum) carboys	ton	30.00	—	.....
Tannic, U. S. P	lb.	1.30	—	1.40
Tannic (tech.)	lb.	.42	—	.60
Tartaric, crystals	lb.	.82	—	.85
Tungstic, per lb. of WO_3	lb.	1.20	—	1.40
Alcohol, Ethyl	gal.	4.00	—	4.85
Alcohol, Methyl	gal.	1.20	—	1.23
Alum, ammonia lump	lb.	.03½	—	.04½
Alum, potash lump	lb.	.08	—	.10
Alum, chrome lump	lb.	.15	—	.17
Aluminium sulphate, commercial	lb.	.01¾	—	.03
Aluminium sulphate, iron free	lb.	.02½	—	.03
Aqua ammonia, 26 deg., drums	lb.	.06¾	—	.08
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.30	—	.....
Ammonium carbonate, powder	lb.	.12½	—	.13½
Ammonium chloride, granular(white salammoniac)	lb.	.12¾	—	.14
Ammonium chloride, granular(gray salammoniac)	lb.	.12	—	.14
Ammonium nitrate	lb.	.10	—	.17
Ammonium sulphate	lb.	.05	—	.06
Amyl acetate	gal.	3.75	—	3.80
Arsenic, oxide, lumps	lb.	.09	—	.09½
Arsenic, sulphide, powdered	lb.	.30	—	.32
Barium chloride	ton	75.00	—	85.00
Barium dioxide (peroxide)	lb.	.19	—	.24
Barium nitrate	lb.	.10	—	.12
Barium sulphate (precip.) (blanc fixe)	lb.	.01¾	—	.03
Bleaching powder (see calcium hypochlorite)		.....	—	.....
Blue Vitriol (see copper sulphate)		.....	—	.....
Borax (see sodium borate)		.....	—	.....
Brimstone (see sulphur, roll)		.....	—	.....
Bromine	lb.	.40	—	.50
Calcium acetate	lb.	.02	—	.02½
Calcium carbide	lb.	.05½	—	.06
Calcium chloride, fused, lump	ton	19.00	—	25.00
Calcium chloride, granulated	lb.	.01¾	—	.02
Calcium hypochlorite (bleaching powder)	cwt.	1.60	—	2.00
Calcium peroxide	lb.	1.50	—	1.70
Calcium phosphate, monobasic	lb.	.22	—	.23
Calcium sulphate, precipitated	lb.	.10	—	.20
Carbon bisulphide	lb.	.05½	—	.06
Carbon tetrachloride, drums	lb.	.11	—	.14
Carbonyl chloride (phosgene)	lb.	.75	—	1.00
Caustic potash (see potassium hydroxide)		.....	—	.....
Caustic soda (see sodium hydroxide)		.....	—	.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05	—	.08
Cobalt oxide	lb.	1.60	—	1.65
Copperas (see iron sulphate)		.....	—	.....
Copper carbonate, green precipitate	lb.	.28	—	.31
Copper cyanide	lb.	65	—	.70
Copper sulphate, crystals	lb.	.07	—	.08
Cream of tartar (see potassium bitartrate)		.....	—	.....
Epsom salt (see magnesium sulphate)		.....	—	.....
Formaldehyde, 40 per cent	lb.	.20	—	.21
Glauber's salt (see sodium sulphate)		.....	—	.....
Glycerine	lb.	.20	—	.23
Iodine, resublimed	lb.	4.25	—	4.30
Iron oxide, red	lb	.03	—	.18
Iron sulphate (copperas)	cwt.	1.00	—	1.75
Lead acetate, normal	lb.	.12¾	—	.15
Lead arsenate (paste)	lb.	.15	—	.18
Lead nitrate, crystals	lb.	.85	—	.86½
Litharge	lb.	.09½	—	.10½
Lithium carbonate	lb.	1.50	—	.....
Magnesium carbonate, technical	lb.	.12	—	.14
Magnesium sulphate, U. S. P	100 lb.	2.70	—	3.00
Magnesium sulphate, commercial	100 lb.	1.75	—	2.60
Nickel salt, double	lb.	.13	—	.15
Nickel salt, single	lb.	.11½	—	.14
Phosgene (see carbonyl chloride)		.....	—	.....
Phosphorus, red	lb.	.55	—	.65
Phosphorus, yellow	lb.	.35	—	.39
Potassium bichromate	lb.	.25	—	.33
Potassium bitartrate (cream of Tartar)	lb.	.52½	—	.55
Potassium bromide, granular	lb.	.49	—	.50
Potassium carbonate, U. S. P	lb.	.60	—	.70
Potassium carbonate, crude	lb.	.11	—	.14
Potassium chlorate, crystals	lb.	.25	—	.31
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium hydroxide (caustic potash)	lb.	.32	—	.40
Potassium iodide	lb.	3.30	—	3.40
Potassium nitrate	lb.	.19	—	.22
Potassium permanganate	lb.	.55	—	.60
Potassium prussiate, red	lb.	.75	—	.85
Potassium prussiate, yellow	lb.	30	—	.35
Potassium sulphate	ton	225.00	—	.....
Rochelle salts (see sodium potas. tartrate)		.....	—	.....
Salammoniac (see ammonium chloride)		.....	—	.....
Sal soda (see sodium carbonate)		.....	—	.....
Salt cake	ton	10.00	—	15.00
Silver cyanide	oz.	1.19	—	.....
Silver nitrate	oz.	.66½	—	.67½
Soda ash, light	100 lb.	$1.85	—	$2.00
Soda ash, dense	100 lb.	2.25	—	2.50
Sodium acetate	lb.	.06	—	.08
Sodium bicarbonate	100 lb.	2.25	—	2.50
Sodium bichromate	lb.	.07½	—	.09
Sodium bisulphate (nitre cake)	ton	3.00	—	10.00
Sodium bisulphite	lb.	.05	—	.07
Sodium borate (borax)	lb.	.07½	—	.08
Sodium carbonate (sal soda)	100 lb.	1.30	—	1.60
Sodium chlorate	lb.	.15	—	.18
Sodium cyanide	lb.	.30	—	.31
Sodium fluoride	lb.	.10	—	.15
Sodium hydroxide (caustic soda)	100 lb.	3.00	—	3.50
Sodium molybdate	lb.	2.50	—	.....
Sodium nitrate	100 lb.	3.00	—	3.25
Sodium nitrite	lb.	.10	—	.13
Sodium peroxide, powdered	lb.	.25	—	.30
Sodium phosphate, dibasic	lb.	.03¾	—	.05
Sodium potassium tartrate (Rochelle salts)	lb.	.43	—	.45½
Sodium prussiate, yellow	lb.	.18	—	.20
Sodium silicate, solution (40 deg.)	lb.	.01¾	—	.02¼
Sodium silicate, solution (60 deg.)	lb.	.02¼	—	.04¾
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.15	—	1.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.04½	—	.05
Sodium sulphite, crystals	lb.	.03½	—	.04
Strontium nitrate, crystals	lb.	.25	—	.28
Sulphur chloride	lb.	.05	—	.05½
Sulphur, crude	ton	32.00	—	35.00
Sulphur dioxide, liquid, cylinders	lb.	.10	—	.12
Sulphur (sublimed), flowers	100 lb.	3.05	—	3.60
Sulphur, roll (brimstone)	100 lb.	2.70	—	3.15
Tin bichloride (stannous)	lb.	.48	—	.50
Tin oxide	lb.	.60	—	.....
Zinc carbonate, precipitate	lb.	.18	—	.20
Zinc chloride, gran	lb.	.12¾	—	.14
Zinc cyanide	lb.	.49	—	.50
Zinc dust	lb.	.09	—	.11
Zinc oxide, dry American	lb.	.09½	—	.11½
Zinc sulphate	lb.	.03½	—	.04

Coal Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.35	—	.50
Aniline oil, drums extra	lb.	.22	—	.24
Aniline salts	lb.	.28	—	.33
Anthracene, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.00	—	1.15
Benzidine, base	lb.	.95	—	1.15
Benzidine, sulphate	lb.	.90	—	1.10
Benzoic acid, U. S. P	lb.	1.00	—	1.10
Benzoate of soda, U. S. P	lb.	.95	—	1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.24	—	.28
Benzol, 90%, in drums (100 lb.)	gal.	.23½	—	.27
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	3.75	—	4.50
Beta naphthol, sublimed	lb.	.75	—	.80
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85	—	.90
Cresylic acid, 95-97%, dark, in drums	gal.	.80	—	.85
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.50	—	2.25
Dimethylaniline	lb.	.50	—	.57
Dinitrobenzol	lb.	.25	—	.37
Dinitroclorbenzol	lb.	.25	—	.28
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.30	—	.32
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25% tar acids, car lots, in drums	gal.	.38	—	.46
Diphenylamine	lb.	.70	—	.75
H-acid	lb.	1.75	—	2.25
Metaphenylenediamine	lb.	1.20	—	1.80
Monochlorbenzol	lb.	.10	—	.14
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline, crushed in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.06½	—	.07½
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	1.00	—	1.25
Nitrobenzol	lb.	.13	—	.15
Nitro-naphthaline	lb.	.35	—	.45
Nitro-toluol	lb.	.17	—	.20
Ortho-amidophenol	lb.	6.00	—	.....
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	1.25	—	.....
Ortho-toluidine	lb.	.30	—	.45
Ortho-nitro-toluol	lb.	.27	—	.40
Para-amidophenol, base	lb.	2.60	—	3.50
Para-amidophenol, H. Cl	lb.	2.75	—	3.25
Para-dichlor-benzol	lb.	.06	—	.10
Paranitraniline	lb.	1.00	—	1.25
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	1.50	—	1.75
Phthalic anhydride	lb.	1.75	—	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10	—	.13
Pyridin	gal.	2.50	—	.....
Resorcin, technical	lb.	3.50	—	3.75
Resorcin, pure	lb.	6.50	—	7.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.25	—	.30
Salicylic acid, U. S. P	lb.	.30	—	.35
Salol	lb.	.75	—	80
Solvent naphtha, water white, in drums, 100 gal.	gal.	.20	—	.27
Solvent naptha, crude, heavy, in drums, 100 gal.	gal.	.18	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30
Tolidine	lb.	1.75	—	2.50
Toluidine, mixed	lb.	.45	—	.80
Toluol, in tank cars	gal.	.22	—	.24
Toluol, in drums	gal.	.23	—	.30
Xylidine, drums, 100 gal	lb.	.44	—	.46
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	..
Xylol, commercial, in drums, 100 gal	gal.	.23	—	.27
Xylol, commercial, in tank cars	gal.	.22	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.43	—	$0.45
Beeswax, refined, yellow	lb.	.48	—	.55
Beeswax, white pure	lb.	.65	—	.68
Carnauba, No. 1	lb.	.90	—	.95
Carnauba, No. 2, regular	lb.	.75	—	.82
Carnauba, No. 3, North Country	lb.	.63	—	.65
Japan	lb.	.18½	—	.21
Paraffine waxes, crude match wax (white) 105-110 m.p	lb.	.06	—	.07½
Paraffine waxes, crude, scale 124-126 m.p	lb.	.06	—	.06½
Paraffine waxes, refined, 118-120 m.p	lb.	.67½	—	.08½
Paraffine waxes, refined, 128-130 m.p	lb.	.09	—	.10
Paraffine waxes, refined, 133-135 m.p	lb.	.11	—	.12
Paraffine waxes, refined, 135-137 m.p	lb.	.12½	—	.....
Stearic acid, single pressed	lb.	.22	—	.23
Stearic acid, double pressed	lb.	.23	—	.25
Stearic acid, triple pressed	lb.	.24	—	.27

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$0.75
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, ref., sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.58
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.34
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.61
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.24
Hardwood oil, f.o.b. Mich., sp. gr., 1.06-1.08	gal.	.24
Pinewood creosote, ref	gal.	.48

Naval Stores

The following prices are f.o.b., New Nork, for carload lots.

Rosin B-D, bbl	280 lb.	$16.00	--	$16.25
Rosin E-I	280 lb.	16.35	—	16.75
Rosin K-N	280 lb.	17.90	—	19.50
Rosin W. G.-W. W	280 lb.	19.75	—	20.00
Wood rosin, bbl	280 lb.	15.50	—	......
Spirits of turpentine	gal.	1.05	—	......
Wood turpentine, steam dist	gal.	.96	—	......
Wood turpentine, dest. dist	gal.	.93	—	......
Pine tar pitch, bbl	200 lb.	8.00	—	8.25
Tar, kiln burned, bbl. (500 lb.)	bbl.	12.50	—	13.50
Retort tar, bbl	280 lb.	13.50	—	14.50
Rosin oil, first run	gal.	.81	—	.83½
Rosin oil, second run	gal.	.83	—	.85½
Rosin oil, third run	gal.	.85	—	1.02½
Rosin oil, fourth run	gal.	.88	—	1.05

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.55	—	0.55½
Upriver coarse	lb.	.32	—	.33
Upriver caucho ball	lb.	.32½	—	.33
Plantation—First latex crepe	lb.	.39½	—	.40½
Ribbed smoked sheets	lb.	.38	—	.39
Brown crepe, thin, clean	lb.	.35	—	.36
Amber crepe, No. 1	lb.	.36	—	.37½

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.19	—	$0.21
Castor oil, AA, in bbls	lb.	.21	—	.23
China wood oil, in bbls	lb.	.21	—	.22½
Cocoanut oil, Ceylon grade, in bbls	lb.	.19½	—	.20
Cocoanut oil, Cochin grade, in bbls	lb.	.21	—	.22
Corn oil, crude, in bbls	lb.	.21	—	.22
Cottonseed oil, crude (f.o.b. mill)	lb.	.22	—	.23
Cottonseed oil, summer yellow	lb.	.27	—	.30
Cottonseed oil, winter yellow	lb.	.27	—	.28
Linseed oil, raw, car lots	gal.	1.90	—	2.10
Linseed oil, raw, tank cars	gal.	1.90	—	1.95
Linseed oil, boiled, car lots	gal.	1.90	—	2.10
Olive oil, commercial	gal.	2.25	—	2.50
Palm, Lagos	lb.	.17½	—	.18
Palm, bright red	lb.	.17	—	.18
Palm, Niger	lb.	.16	—	.17
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.23½	—	.24
Peanut oil, refined, in bbls	lb.	.28	—	.29
Rapeseed oil, refined in bbls	gal.	1.55	—	1.60
Rapeseed oil, blown, in bbls	gal.	1.60	—	1.65
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.19½	—	.20
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.16½	—	.17½

FISH

Winter pressed Menhaden	gal.	$1.20	—	1.25
Yellow bleached Menhaden	gal.	1.22	—	1.27
White bleached Menhaden	gal.	1.24	—	1.30
Blown Menhaden	gal.	1.26	—	1.35

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00	—	$36.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	30.00	—	40.00
Casein	lb.	.16	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	11.00	—	15.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	$30.00	—	$35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	30.00	—	40.00
Fuller's earth, imported, powdered	ton	.....	—	.....
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	.....	—	.....
Shellac, D.C	lb.	.....	—	.....
Shellac, V. S. O	lb.	.....	—	.....
Shellac, Diamond I	lb.	.....	—	.....
Shellac, orange, fine	lb.	.....	—	.....
Shellac, orange, superfine	lb.	1.10	—	1.15
Shellac, A.C. garnet	lb.	.95	—	.....
Shellac, bleached, bone dry	lb.	1.35	—	.....
Shellac, bleached, fresh ground	lb.	1.05	—	.....
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	55.00	—	60.00

Refractories

Following prices are f. o. b. works:

Chrome brick	net ton	90–100 at Chester, Penn.
Chrome cement	net ton	45–50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35–45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30–35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50–55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80–90 at Chester, Penn.
Silica brick	net ton	41–45 at Mt. Union, Penn.

Ferro-alloys

All prices f. o. b. works.

Ferro-carbon-titanium, 15–18%, f.o.b. Niagara Falls, N. Y	net ton	$220.00	—	....
Ferro-chrome, per lb. of Cr. contained, 6–8% carbon	lb.	.32	—	$0.40
Ferro-chrome, per lb. of Cr. contained, 2–4% carbon	lb.	.70	—	....
Ferro-manganese, 70-80% Mn	gross ton	100.00	—	125.00
Spiegeleisen, 16-20% Mn	gross ton	30.00	—	50.00
Ferro-molybdenum, per lb. of Mo	lb.	2.00	—	3.00
Ferro-silicon, 50%	gross ton	85.00	—	115.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10–15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.30	—	1.60
Ferro-uranium, 35-50%, of U	lb.	7.00	—	....
Ferro-vanadium, 30-40%, per lb. of contained V.	lb.	5.50	—	7.00

Resales and overstocks make above prices approximate.

Ores and Semi-finished Products

Chrome ore, 35-40%, Cr_2O_3	unit	$0.70		
Chrome ore, 48% and over	unit	.80	—	
Coke, foundry, f.o.b. mines	net ton	5.00	—	$5.50
Coke, furnace, f.o.b. mines	net ton	4.50	—	5.00
Petroleum coke, f.o.b. Atlantic seaboard	net ton	16.00	—	16.50
Fluorspar, gravel, f.o.b. mines	net ton	20.00	—	25.00
Manganese ore, 45% Mn and over	unit	.60	—	.65
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over per unit of WO_3	unit	9.00	—	11.50
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	—	8.00
Uranium oxide, 96%	lb.	.....	—	.....
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.15	—	.....
Pyrites, foreign, fine	unit	.15	—	.....
Pyrites, domestic, fine	unit	.14	—	.....
Ilmenite, 50% TiO_2	net ton	30.00	—	.....
Rutile, 95% TiO_2	net ton	200.00	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00

Resales and overstocks make above prices approximate.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	15.00
Hollow building tile, At factory, Perth Amboy, N. J. 8x12x12	M.	194.40
Hollow building tile, At factory, Perth Amboy, N. J. 12x12x12	M.	291.60
Yellow pine, 3x4 to 8x8, 20-24 ft. long	M.	40.00
Yellow pine, 3x4 to 8x8, 20-24 ft. long at Chicago	M.	39.50
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis	M.	37.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	60.00
Roofings, tar pitch (in 400-lb. bbl.)	ton	21.00
Roofings, asphalt pitch	ton	34.00
Roofings, asphalt felt	ton	63 00
Roofings, slate-surfaced, per roll of 108 sq.ft.		2.00
Roofings, slate-finished shingles, 100 sq.ft.		5.00
Linseed oil, raw in barrels	gal.	2.15
Linseed oil, 5 gal. cans	gal.	2.28
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanised corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

California

CLAREMONT—The trustees of Pomona College have received a donation of $100,000 for the construction of a chemistry hall.

LINDSAY—The city voted $85,000 bonds for the construction of a gas system. Olmsted & Gillelen, 1112 Hollingsworth Bldg., Los Angeles, engineers.

SACRAMENTO — The City Commissioners voted $1,800,000 bonds for the construction of a filtration plant for the municipal water system. T. Coulter, Commissioner of Public Works. Noted Jan. 15.

Connecticut

WATERBURY—The city will install a chemical laboratory in the basement of the 1-story garage which it plans to build. Esimated cost, $60,000. Cass Gilbert, 244 Madison Ave., New York City, N. Y., architect.

Florida

ARCHER—The Archer Cane Manufacturing Co., plans to build a large cane mill for making high grade syrup. A. D. Lindsay, president.

KEY WEST—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for installing oil burning equipment here, to the South Florida Contracting & Engineering Co., Eaton and Elizabeth Sts. Estimated cost, $5,800.

WEST PALM BEACH—The State Board of Health plans to install a modern filtration plant. Estimated cost, $75,000. Address G. W. Simmons, Jr.

Illinois

CHICAGO—Sears, Roebuck & Co., Arlington and Homan Aves., plans to build a 5-story paint factory on Kostner Ave. and Fillmore St. Estimated cost, $250,000. G. C. Nimmons & Co., 122 South Michigan Ave., architect.

GREAT LAKES—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for remodeling the sewage disposal plant here, to Hansen Bros. Co., 126 North Dearborn St., Chicago. Estimated cost, $17,481.

Indiana

INDIANAPOLIS — The Smith Dye Works, 581 Warsaw St., has awarded the contract for the construction of a 1-story, 30 x 65-ft. dry cleaning plant, to T. A. Moynahan, 1947 Broadway.

NEW ALBANY—The Calumet Fertilizer Co. has awarded the contract for the construction of a 48 x 65-ft. plant, to E. Embrey, New Albany. Estimated cost, $15,000. Noted May 15.

Iowa

STRAWBERRY POINT — The town plans to build one mile of sanitary sewers and a sewage disposal plant. W. F. Reinecke, mayor. H. R. Green, Union Block, Cedar Rapids, engineer.

Kansas

TREECE—The Early Bird Mining Co., Baxter Springs, will install an additional jig plant and is in the market for rolls, elevator pulleys, belting, shafting, etc. C. Bird, superintendent.

Kentucky

ASHLAND—The Board of Water Commissioners will receive bids until July 24 for the construction of a 2,000,000-gal. filtration plant and a centrifugal pumping plant of seven units. Alvord & Burdick, 4 South Dearborn St., Chicago, Ill., engineer. Noted May 15.

Louisiana

BATON ROUGE—The Aluminum Ore Co., East St. Louis, Ill., has acquired 227 acres near here and plans to build an aluminum ore refinery. Esimated cost, $1,000,000. C. E. Rudisill, c/o owner, engineer.

Maryland

CUMBERLAND—The American Cellulose Chemical Manufacturing Co., Ltd., plans to build an addition to its plant. Estimated cost, $1,000,000.

Massachusetts

PALMER—The Clinton-Wright Wire Co., Hammond St., Worcester, plans to build a 1-story steel plant here. Estimated cost, $100,000.

TURNERS FALLS—The Esleeck Manufacturing Co. plans to build a 5-story addition to its paper manufacturing plant here. Esimated cost, $75,000.

Michigan

DETROIT—The Detroit Seamless Tube Co., 841 West Jefferson Ave., has awarded the contract for two 1-story, 90 x 550-ft. additions to its plant, to be equipped with modern machinery for the manufacture of steel tubes, to A. A. Albrecht & Co., 1130 Penobscot Bldg. Estimated cost, $1,700,000.

Missouri

MACON—W. H. Martin, city clerk, has awarded the contract for the construction of a sewage disposal plant, to W. McClurken, 3807 Westminster Ave., St. Louis. Estimated cost, $16,000.

ST. LOUIS—The St. Louis Surfacer & Paint Co., Arlington and Terminal R.R., has awarded the contract for the construction of a 2-story, 28 x 47-ft. factory at 5438 Hazel St., to the W. R. Wilson Building Co., Odd Fellows Bldg. Estimated cost, $10,000.

WACO—The Union Metal Mines Co. plans to build a new concentrating mill at its mine in Waco Field, Kan., and is in the market for material for same. P. B. Bitler, general manager.

WEBB CITY—The Orange Mining Co. plans to enlarge its plant in every department and is in the market for crushers, rolls, hoists and compressor. H. H. Wallower, supt.

Montana

HELENA—The State Board of Examiners will soon award the contract for the construction of a laboratory for the Board of Health. Haire & Link, Power Bldg., architects. Noted April 1.

Nebraska

LINCOLN—The Lincoln Paint & Color Co., 811 M St., will rebuild its 2-story, 50 x 80-ft. paint factory recently destroyed by fire, entailing a loss of $25,000.

New Jersey

TRENTON—The city plans to build a sewage disposal plant. Estimated cost, $500,000. J. R. Fell, 134 North Montgomery St., engineer.

TRENTON—The Hamilton Rubber Co., Clinton and Mead Sts., has awarded the contract for the construction of a 3-story, 75 x 75-ft. plant, to Aitken & Bebbington, 115 South Stockton St. Estimated cost, $20,000.

TRENTON—The Luzeren Rubber Co., Muirheid Ave., has awarded the contract for the construction of a 2-story, 50 x 75-ft. addition to its rubber plant, to N. A. K. Bugbee Co., 204 East Hanover St. Estimated cost, $13,000.

TRENTON—The Stokes Rubber Co., Taylor St., has awarded the contract for the construction of a 1-story, 50 x 100-ft. addition to its plant, to N. A. K. Bugbee Co., 204 East Hanover St. Estimated cost, $8500.

New York

ALBANY—Dr. H. M. Biggs, Commissioner of Health, State Department of Health, Capitol, Albany, will receive bids until July 22 for installing apparatus and equipment in the laboratory building here, to include experimental extractions and distilling apparatus, water stills, autoclaves, etc. Estimated cost, $6000.

POUGHKEEPSIE—The State Hospital Commission, Capitol, Albany, has awarded the contract for altering and building additions to the water supply system at the Hudson River State Hospital, here, to the Baker-Dunbar-Allen Co., Stock Exchange Bldg., Philadelphia, Pa. Plans include installing additional filters, etc. Estimated cost, $52,000. Noted June 1.

North Carolina

CLINTON—The Sampson Oil & Fertilizer Co. plans to build a fertilizer factory. Estimated cost, $75,000. American Machine & Manufacturing Co., Greenville, S. C., architect.

Ohio

CLEVELAND—The Cleveland Electro Metals Co., 421 Guardian Bldg., has awarded the contract for the construction of a 2-story, 40 x 50-ft. addition to its factory at 2391 West 38th St., to the Drummond Miller Co., 422 Guardian Bldg. Estimated cost, $6000.

CLEVELAND—The Crucible Steel Castings Co., Canel Rd. and Champlain Ave., plans to build a 2-story, 125 x 300-ft. factory on Almira and Denison Aves. Estimated cost, $100,000.

CLEVELAND—The Ideal Tire & Rubber Co., East 17th St. and Euclid Ave., plans to build a 3-story, 100 x 200-ft. addition to its factory on Warren Rd. Estimated cost, $125,000.

CLEVELAND—The Vitreous Enameling Co., 6800 Grant Ave., has awarded the contract for the construction of a 1-story, 90 x 120-ft. factory on East 71st St. and Grant Ave., to W. Dunbar Co., 8201 Cedar Ave. Estimated cost, $35,000.

CLEVELAND—The National Copper & Smelting Co., Rose Bldg., plans to build a 3-story, 75 x 240-ft. factory on Babitt Rd. and Nickelplate Ry. Estimated cost, $25,000.

COLUMBUS—The Timkin Roller Bearing Co., Dueber Ave., Canton, has acquired a site and plans to build a 300 x 500-ft. branch plant here. Estimated cost, between $1,000,000 and $1,500,000. H. H. Timkin, president.

DAYTON—The Dayton Steel Co., Howell and Parker Sts., plans to build a factory for the manufacture of fabricated structural steel and bridges. Estimated cost, $35,000.

Pennsylvania

PHILADELPHIA—Firth & Foster, Emerald and Foster Sts., have awarded the contract for the construction of a 1-story, 64 x 68-ft. dye house, to F. A. Havens Co., 845 North 19th St. Estimated cost, $20,000.

PITTSBURGH—The Basic Mineral Co., 834 Columbus Ave., N. S., is having plans prepared by Leffler & Schubert, architects, North Side, for the construction of a 2-story, 75 x 75-ft. addition to its plant on Columbus Ave., for the manufacture of flux and deodorizer for melting metals. Plans include laboratory, mill and electric furnaces. Estimated cost, $25,000.

WILLIAMSPORT—The J. K. Mosser Tannery Co., a subsidiary of the Armour Leather Co., Newberry, will soon receive bids for the construction of a 6-story, 150 x 196 x 202-ft. tannery, on Arch St., here.

South Dakota

DEADWOOD—The Capital Gold Mining & Milling Co., 405 Brandies Theatre Bldg., Omaha, Neb., plans to build an air compressor plant, power line, etc., and is in the market for complete equipment. Estimated cost, $10,000. R. M. Harrop, general manager.

Tennessee

COLUMBIA—The Victor Chemical Co., Fisher Bldg., Chicago, Ill., plans to build a chemical plant near here. W. B. Brown, vice-president.

Washington

KELSO—The Union Oil Co. of California, Mills Bldg., San Francisco, has purchased a site and plans to build an oil distributing plant, including one 20,000-gal. distillate tank, one 20,000-gal. gasoline tank and one 20,000-gal. coal oil tank, at North Kelso. C. C. Ireland, representative.

SEATTLE—The West Coast Rubber Co., 4060 Occidental Ave., has awarded the contract for the construction of a 1-story, 112 x 153-ft. factory for the manufacture of rubber products, on 7th and Mercer Sts., to J. W. Johnson, 171 McGraw St. Estimated cost, $26,000.

SPOKANE—The International Steel Co. has purchased a site along the Chicago, Milwaukee & St. Paul R.R., and plans to build a steel rolling mill, to be equipped with electric furnaces. Estimated cost, $100,000. L. L. Bair, president.

Wisconsin

CARROLLVILLE—The United States Fertilizer Co., c/o U. S. Glue Co., has awarded the contract for the construction of a 2 and 3-story, 67 x 219 and 50 x 50-ft. fertilizing plant, to P. Riesen & Sons, 1018 Humboldt Ave., Milwaukee, Estimated cost, $100,000. Noted July 1.

Ontario

HAMILTON—The Quaker City Chemical Co., Philadelphia, Pa., plans to build a 3-story, 60 x 120-ft. chemical plant here. Estimated cost, $120,000. C. H. Mackay, Hamilton, Ont., engineer.

LONDON—C. S. Hyman, Richmond St., plans to build a new tannery. Estimated cost, $300,000. W. F. D. Jarvis, manager.

OWEN SOUND—The Dominion Oil Co. will receive bids until July 18 for the construction of a 3-story, 38 x 70-ft. plant for the manufacture of oils, greases and soaps. Estimated cost, $30,000.

PORT ARTHUR—The Carrick Pulp Mills plans to build an extension to its plant, in order to increase the capacity to 350 tons.

TORONTO — Baldwins of Swansea, Wales, England, plans to build steel rolling mills on Ashbridges Bay, here. Estimated cost, $3,000,000.

WINDSOR—The City Council plans to install filters at the waterworks. Estimated cost, $300,000. Address I. F. Smith.

Quebec

MONTREAL—The T. Davidson Manufacturing Co., 187 Delisle St., has awarded the contract for the construction of a 75 x 100-ft. factory for the manufacture of enamel wares, to A. F. Byers & Co., 340 University St. Estimated cost, $75,000.

Manufacturers' Catalogs

The Trumpbour-Whitehead Brass & Copper Co., Inc., has recently issued a booklet on monel metal. Of particular interest is the result of tests given this metal in the College of the City of New York in 1913, which are described.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has published illustrated catalog No. 107 descriptive of concentrating machinery and equipment. The catalog contains a brief treatise on principles of concentration, together with flow-sheets of typical mills in different parts of the country. An attractive booklet is also being distributed on the works and products of the company.

The Celite Products Co., New York City, has just issued Bull. B-13 describing the use and application of Sil-O-Cel plastic cement for preventing heat losses and increasing the capacity of high-temperature equipment. Copies will be sent on request.

The Metal & Thermit Corp., New York, N. Y., has issued a folder entitled "How Thermit Healed My Broken Jaw," which illustrates the operations involved in making a thermit weld on the 13½-ton broken upper jaw of an alligator shear used by Jos. Joseph & Bros. Co., Modena, Pa. The break welded was 80 in. in length and varied from 4½ to 23 in. in thickness.

Hungerford & Terry, Inc., calls attention to a general catalog of Hungerford filters which is now ready for distribution. This publication describes the full line.

The Buffalo Forge Co., Buffalo, is distributing Section No. 400 on fans, blowers and exhausters, which are illustrated and described.

The Hooker Electrochemical Co., New York, has gotten out new folders on muriatic acid, bleach and liquid chlorine which the company will be glad to send to any one interested.

The Dorr Co., New York and Denver, has published Bull. No. 13 describing the Dorrco pump. This is a 16-page bulletin containing tables of dimensions, weights, capacities, etc., part lists, instruction for operating and illustrations.

The Jeffrey Manufacturing Co., Columbus, Ohio, announces a new catalog No. 258 on standard apron conveyors. This catalog contains 75 pages, devoted to installations showing standard steel and wood apron conveyors in service in various industries, specifications, general dimensions and other important data.

The Irving Iron Works Co., Long Island City, has issued a booklet called "Irving Subway," which is the fireproof metallic ventilating flooring.

The General Chemical Co., New York, has gotten up an attractive book which is an extended report covering twenty years, from March 1, 1899, to March 1, 1919, and tells of its origin, organization facilities, field of activity and accomplishments.

The Cement Gun Construction Co., Chicago, Ill., has just issued Gunite Book No. 6, entitled "We Do the Work," with illustrations of recent cement gun work.

The William P. Pollock Co., Youngstown, Ohio, has just received from the press Vol. No. 31, which contains a series of photographs of modern blast-furnaces.

The Bastian-Blessing Co., Chicago, Ill.: "Rego Welding and Cutting Apparatus" is the title of a new publication just issued by this company.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis., calls attention to a new bulletin on the value of accurate measurements of gases and air in a gas plant, coke oven plant, steel plant or chemical plant.

The Austin Co. has just issued a new catalog of standard buildings which contains drawings, illustrations and specifications of each of the ten standard types, together with complete information concerning the scope of Austin Building Service.

The Colorado Iron Works Co., Denver, Colo., announces pamphlet No. 9-C on the improved impact screen for the wet or dry sizing of all kinds of materials.

The W. S. Rockwell Co., New York, has published Bull. No. 42 on cost of heating of steel, which deals with fuel and labor conservation in a forge shop; the economizer forge is illustrated and described. In Bulletin No. 34 the application of the economizer principle of the economizer forge is fully illustrated and described. Copies will be sent upon request.

R. D. Muttall Co., Chicago, Ill., has gotten out a pamphlet on "Pedigreed Gears," which contains illustrations and descriptive matter.

The Merrill Co., San Francisco, Cal., calls attention to a new catalog on "The Nordstrom Lubricated Plug Valve."

The Geo. C. Videtto Machinery Co., Pittsburgh, Pa., has issued leaflets on standard bucket elevators, self-traction trucks, self-feeding bucket loaders, etc.

The Gifford-Wood Co., Hudson, N. Y.: Bull. 42 on Field and Basin Saws illustrates and describes the many different types and what users say of their performance.

The Standard Spiral Pipe Works, Chicago, Ill., is distributing Cat. No. 7, which deals with smooth bore reinforced spiral pipe, valves, cast-iron fittings, special steel fittings, hydraulic supplies, forged steel flanges and drop forgings.

The Wellman-Seaver-Morgan Co., Cleveland, Ohio, has issued Bull. No. 17 on the Hughes Mechanical Gas Producer.

The Thompson-Starrett Co., New York, has just published two very interesting brochures. The first brochure, "Building and Industrial Construction," illustrates and describes the many types of buildings put up by this company, including the Municipal Building in New York, office buildings, hotels, exhibit buildings, museums, power houses, forging and machine plants and manufacturing plants of all kinds. The title of the second brochure is "Building for Victory," by Col. W. A. Starrett. This is a reprint of an article which appeared in *Scribner's* for November, 1918, which describes and illustrates the work of this company on the $50,000,000 powder plant at Nitro, West Virginia, which was built under the direction of D. C. Jacking, acting as director of explosives for the Secretary of War, and the Yaphank Cantonment, which was built in 100 days.

The Tide Water Oil Co., New York, has issued a booklet on Fuel Oil, which is for use by engineers, plant managers and all those who are interested in fuel oil and its various applications for raising steam for power, for furnaces, gas making, etc. It contains formulæ for computing the relative cost of fuel vs. coal and comprehensive data on the instruments, tanks and other appliances necessary for its most efficient use.

Industrial Notes

The Electric Furnace Co., Alliance, Ohio, has just shipped one of its standard hose tilting type furnaces to the United States Navy Yard, at Washington, D. C. to be used in the Government brass foundry there. This furnace is provided with a motor-operated tilting mechanism and has a maximum hearth capacity of 2000 lb. The shell is 7 ft. in diameter and the furnace is rated at 105 kw. in electrical capacity.

Mr. T. Linsey Crossley, who has been associated for a number of years with J. T. Donald & Co., consulting chemists, has taken over the Toronto office and laboratory of that firm at 43 Scott St., and will there carry on the business of consulting chemist and chemical engineer. Besides general consultation work, Mr. Crossley has specialized in municipal chemistry and the technology of pulp and paper manufacture.

The Austin Co., Cleveland, Ohio, announces the engagement of Mr. O. D. Conover as production and sales engineer on foundries and steel plants. Mr. Conover was formerly vice-president and chief engineer of the T. W. Price Engineering Co. of New York and production manager of the Ludlum Electric Furnace Corp. Mr. Conover's headquarters will be at the Cleveland office of the Austin Co.

The first heat of steel from the Greaves-Etchells electric furnace at the League Island Navy Yard, Philadelphia, was made July 1. The furnace was recently installed in the new foundry by the Electric Furnace Construction Co., Philadelphia, Pa. The Electric Furnace Construction Co. also announces that it has received an order for an electric furnace for the manufacture of ferro-alloys for Spain, from the Sociedad Española de Construccion Naval, the advisory committee of which consists of the firms of Sir W. G. Armstrong Witworth & Co., Vickers, Ltd., and John Brown & Co. This is the first furnace of its kind to be erected in Spain for converting that country's natural ores into ferro-alloys.

The J. P. Devine Co., Buffalo, N. Y., has recently completed or has in process of construction several new additions to its plant for the manufacture of chemical apparatus. One of the additions, 30 ft. x 100 ft., is housing the department for the assembling of vacuum pumps; another, 90 ft. x 100 ft., now in course of construction, will enlarge the general assembling department. Construction is proceeding on a new foundry, 90 ft. x 225 ft., which will give greatly increased facilities for making large castings. Employment will be provided for 200 additional men.

The *C-H Messenger*, the shop newspaper of the Cutler-Hammer Mfg. Co., contains in a recent issue photographs and names of many of the company's men who served in the recent war. The list is incomplete, but there are nearly 300 names on this Roll of Honor.

The Morgan Construction Co. announces that the Cambria Steel Co. has installed 51 Morgan gas producers at the Franklin furnaces at the Weirton Steel Co. of Weirton, W. Va., and is building an entirely new open-hearth and blooming mill plant containing 27 Morgan producers. The same equipment has been purchased by four British steel plants this year.

The George J. Hagan Co., Pittsburgh, Pa., has closed a contract with a French company for the purchase of foreign rights on the Hagan Co.'s patented devices for sheet, tin-mill and job-mill furnaces. The contract was closed for a large cash consideration and gives the French company rights in all European countries. The Hagan Co. reports important sales of its patented furnaces to the Eastern Rolling Mill Co., Baltimore, the American Sheet & Tin-Plate Co., Gary; the LaBelle Iron Works, Canton Sheet Steel Co., Otis Steel Co., and the Newport Rolling Mill Co.

Messrs. H. D. Staley and G. A. Fisher, doing business under the name of the Western Steel & Engineering Co., 35 Montgomery St., San Francisco, have been appointed California representatives for the United Filters Corp.

The Stephens-Adamson Mfg. Co., Aurora, Ill., announces its new representation in the San Francisco district. The firm of Bannon, Bodinson, MacIntyre, Inc., 317 Market Street, San Francisco, will have charge of the engineering sales work in this territory.

The New Jersey Zinc Co. of New York has just established warehouses in San Francisco and Los Angeles from which its products will hereafter be distributed to its trade on the Pacific Coast.

The Nash Engineering Co., South Norwalk, Conn., announces a change in the trade name of its pumps from Nash hydroturbine to "Hytor."

The Standard Car Construction Co. and the Standard Car Equipment Co. are now merged under the name of the Standard Tank Car Co., with head offices and works at Sharon, Pa.

The Westinghouse Church Kerr & Co., Inc., announces the election of Mr. Arthur K. Wood, formerly president of the Franklin Trust Co., as vice-president and treasurer.

The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., announces the appointment of Mr. C. S. Coler as manager of the educational department of the Westinghouse Co., and president of the Casino Technical Night School, an institution supported by the Westinghouse Co., to promote the education of its employees who wish to study in the evening. Mr. Coler is also president of the local chapter of the National Association of Corporation Schools, a member of the Society for the Promotion of Engineering Education and chairman of the technical sections of the Westinghouse Club.

The John Johnson Co. of Brooklyn, N. Y., announces the appointment of Mr. James N. Vermilya as sales engineer. Mr. Vermilya will devote his attention as chemical engineer principally to filtration and mixing problems encountered in the chemical industry.

The Edison Storage Battery Co. announces the election of Mr. Charles E. Sholes as vice-president, director and general sales manager, succeeding Mr. Harrison G. Thompson. Mr. Sholes was formerly with the Grasselli Chemical Co., and during the war was commissioned a Major in Ordnance. He is chairman of the New York Section of the Society of Chemical Industry and a member of many other scientific societies.

The American Steam Conveyor Corp. announces the appointment of Samuel F. Joor as sales engineer. Mr. Joor was formerly Western manager and sales engineer of the Jeffrey Manufacturing Co.

The Bailey Meter Co. announces the removal of its main office and works to East 46th Street, Euclid, Cleveland, Ohio. The Boston office will be retained to render service in the New England and Atlantic coast states. This company also announces the appointment of Mr. E. A. Hitchcock, formerly professor of experimental engineering at Ohio State University, as vice-president, supervising the training of technical graduates for the service and sales department.

The American-LaFrance Fire Engine Co., Inc., of Elmira, N. Y., is employing for the protection of chemical fire apparatus an acid and alkali resisting paint which was developed for the company at the laboratory of Arthur D. Little, Inc., of Cambridge, Mass.

Some time ago *The Little Journal* published an account of the Eckert process of increasing the growth of sugar cane and preventing the growth of weeds in Hawaii by covering rows of young cane with yard-wide sheets of a specially prepared paper. The cane shoots, being stiff and sharp, perforate the paper, while the weeds curl up and die. At the experimental paper mill of Arthur D. Little, Inc., of Cambridge, Mass., a method was developed to make this special paper from bagasse, or cane from which the sugar has been extracted. Later, the same organization built a mill in Hawaii for the Olaa Sugar Co., of which the patentee, Mr. C. F. Eckert, is manager, and it is now in successful operation.

Hamilton & Hansell, Inc., New York, announces the sale of a Rennerfelt furnace of 300-lb. capacity and 60 k.v.a. to the General Chemical Co., to be installed at Laurel Hill, Long Island.

The Blaw-Knox Co. has sold its plant at Wheatland, Pa., in accordance with its program to concentrate all of its manufacturing at Hoboken, Pa. About one-half of the new plant at Hoboken has been completed and the entire addition will be finished within a few weeks. The combined plants at Hoboken will afford about 30 per cent more floor space than was available in the two separate plants. In addition to these activities the company is completing a welding plant and will specialize in this line on steel mill and chemical plant requirements.

Mr. Mark R. Lamb, who has been engaged in purchasing for export, has secured control of the New York Steel Exchange, Inc., with which he has combined his own export business. This merger of specialized mining and heavy machinery export business with the export line of iron and steel products will give increased facilities for handling new European business. The new organization will operate under the corporate name of the New York Steel Exchange, Inc., and will be under the immediate management of Mr. Lamb.

The York Steel Corp., York, Pa., which was recently organized, has purchased an 80-acre tract of land just outside of the city on which it will erect a plant for the manufacturing of sheet steel, to be supplied to the York Corrugating Co.

Mr. E. E. Maher announces the formation of the Maher Engineering Co., with offices in the Michigan Boulevard Bldg., Chicago, Ill., to handle the sale and installation of Erie Engine Works high speed engines, the Sims Co. feed water heaters, Dayton-Dowd Co. centrifugal pumps, Wagener Steam Pump Co. pumps and Pratt Engineering & Machine Co. fertilizer and sulphuric acid machinery.

The Chicago Pneumatic Tool Co. announces the appointment of Mr. L. C. Sprague, formerly district manager of sales at New York, as manager of Western railroad sales, with headquarters in the Fisher Bldg., Chicago, and Mr. H. G. Barbee as manager of Eastern railroad sales, with headquarters at 52 Vanderbilt Ave., New York City. Mr. Nelson B. Gatch, formerly district manager of sales at Chicago, has been appointed district manager of sales at New York, succeeding Mr. Sprague.

The Midwest Engine Co., Indianapolis, Ind., manufacturer of pumping equipment, announces the opening of four new offices, as follows: Florida Life Bldg., Jacksonville, Fla., in charge of D. J. Carrison; 303 Caples Bldg., El Paso, Tex., in charge of Chester B. Loomis; 111 Broadway, New York City, in charge of B. H. Downing; 617 Maison Blanche Bldg., New Orleans, La., in charge of J. R. Lowe.

Coming Meetings and Events

The American Ceramic Society will hold a meeting in Chicago, Sept. 24.

The American Chemical Society will hold its Fall meeting in Philadelphia, Pa., Sept. 2-6 inclusive.

The American Electrochemical Society will hold its Fall meeting in Chicago, Sept. 23-25 inclusive.

The American Foundrymen's Association will hold its 1919 convention in Philadelphia, Sept. 29 to Oct. 4.

The American Institute of Mining and Metallurgical Engineers will hold its Fall meeting in Chicago, Ill., Sept. 22-27.

The American Steel Treaters' Society will hold its first annual convention in Chicago, Ill., Sept. 22-27.

The Fifth National Exposition of Chemical Industries will be held in Chicago, Ill., Sept. 22-27 inclusive.

The Institute of Metals Division of the A. I. M. E. will hold its next meeting in Philadelphia, Pa., Sept. 29 to Oct. 4.

The Institute of Metals will hold its Autumn meeting in Sheffield, England, Sept. 24-25.

The Technical Association of the Pulp and Paper Industry will hold its Fall meeting in Chicago from Sept. 24 to 27.

New Publications

New Bureau of Standards Publications: Circ. No. 82. Recommended specification for linseed oil—raw, refined and boiled; Scientific Paper No. 336. A simplification of the inverse-rate method for thermal analysis. By P. D. Merica; No. 125. Viscosity of gasoline. By Winslow H. Herschel, issued May 5, 1919; No. 128. Effect of solar radiation upon balloons. By Junius Davis Edwards and Maurice Blaine Long, issued June 13, 1919.

The United States Tariff Commission: Report on dyes and related coal-tar chemicals, 1918.

The Department of Commerce: International Price Comparisons. By Wesley C. Mitchell, assisted by Margaret L. Goldsmith and Florence K. Middaugh.

New Bureau of Mines Publications: Bull. 165. Bibliography of petroleum and allied substances in 1916. By E. H. Burroughs; Bull. 168. Recovery of zinc from low-grade and complex ores. By Dorsey A. Lyon and Oliver C. Ralston; Bull. 177. The decline and ultimate production of oil wells, with notes on the valuation of oil properties. By Carl H. Beal; Bull. 179. Abstracts of current decisions on mines and mining, reported from Sept. to Dec. 1918. By J. W. Thompson; Tech. Paper 222. Method of administering leases of iron-ore deposits belonging to the State of Minnesota. By J. R. Finlay; Tech. Paper 223. Cost keeping for small metal mines. By J. C. Pickering; Tech. Paper 224. Metal-mine accidents in the United States during the calendar year 1917 with supplemental labor and accident tables for the years 1911 to 1917, inclusive. Compiled by Albert H. Fay; Minerals Investigation Series No. 15. Concentration of native sulphur ores by flotation. By James M. Hyde; No. 16. Uses of manganese other than for steel making. By W. C. Phalen; the fifteenth biennial report of the Bureau of Mines of the States of Colorado 1917-1918; TNT as a blasting explosive. By Charles E. Munroe and Spencer P. Howell, dated June, 1919; War gas investigations. By Van H. Manning, which gives the scope of the war gas investigations and the names of the personnel connected with each division.

Stocks and Bonds

Closing Bid and Asked Quotations July 14, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am.Ag.Ch.	109½	109¾	Mat.Al.Wk.	31	40
do.pf.	98	100	Ten. C. & C.	15⅝	15¾
Barrett Co.	138	140	Un. Dyewood.	63	70
do.pf.	114	116½	do. pf.	97	97⅞
Gen.Chem.	185	195	Va.-Car. Ch.	88½	88⅞
do.pf.	102½	109	do. pf.	115	116
Int.Ag.Ch.	34	34½			
do. pf.	90½	90⅞			

Bonds

	Bid	Ask
Am. Ag. Ch., 1st cv. 5s, '28	98⅞	100
Am. Ag. Ch., cv. db. 5s, '24	108⅝	113
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32	84	84½
Va.-Car. Ch., 1 mtg. 5s, '23	96⅞	96⅞
Va.-Car. Ch., cv. db. 6s, '24	102⅝	103⅝

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co.	92	93	P-A Pet & Tr	104½	105
Cal. Pet.	38¼	38½	do. pf.	...	...
do. pf.	80	81	Pierce Oil	...	...
Col. G. & E.	63	63¼	Royal Dutch	114½	115½
Mex. Pet.	191	191⅞	Sinclair O & R	64⅝	64⅞
do. pf.	107⅞	110	Texas Co.	272⅞	273
Ohio Cit. Gas	59⅞	60	Tex. Pac. Ld. Tr.	400	500
do. pf.			Tidewater Oil	243	245
Ohio Fuel S.	49	52⅞			
Okla. P. & R.	11	11⅝			

Bonds

	Bid	Ask
Columbia Gas & Electric, 1 5s, '27	88	90
Col G. & El., std. 1 5s, '27	88	..
Pan-Am. Pet. & Tr. 1 6s, '19-'27	140	....
Pierce Oil, cv. db. 6s, '20	115	130
Pierce Oil, cv. 5% Notes, '24	106	106½
Sin. O. & R. 1 ln.7s, '20, with stk. war.		150
Sin. O. & R. 1 ln. 7s, '20 without stk. war.	99⅝	99⅞
Texas Co., db. 6s, '31	102⅞	103
Union Oil of Cal. 1 5s, '31	93⅞	94¼
United Fuel Gas 1 mtg. 6s, ser.A, '36	94⅞	97

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F.	44¼	45	Pitts. Ste. pf.	96	97
Beth. Steel	94⅞	95	Rep. Iron & Steel	97½	98
do. class B	95⅞	96	do. pf.	104	104½
do. pf., 8%	...	...	Sloss Sheff. I. & S.	72	73
do. pf., 7%	111¼	112	do. pf.	94¼	98
Central Fdry.	34	34½	Superior Steel	46¼	47
do. pf.	65⅞	67	do. 1 pf.	104	110
Col. F. & I.	55⅞	55¼	Trans. & W. Steel	55	56
do. pf.	105	125	Un. Alloy St.	54½	55
Cruc. Steel	135¼	139¼	U.S.C.I.P.&F.	34⅝	35
do. pf.	103	105	do. pf.	70	73
Great No. Ore	51¼	51¼	U. S. Steel	111⅞	111⅞
Gulf Sta. Steel	69⅝	70	do. pf.	116⅞	116⅞
do. 1 pf.	94	98	Va. Coal, I&C.	67½	69
Lack. Steel	86½	87			
Mid.St.& Ord.	59⅝	59½			
Nova Scotia Steel	83	84			

Bonds

	Bid	Ask
Beth. Steel, 1 ext. gtd. S.F. 5s, '26	96⅝	96½
Beth. Steel, 1 ln. ref. 5s, Ser. A, '42	92	92⅝
Beth. Steel, P. M. & I. S. F. 5s, '36	88	88½
Buff. & Susq. Iron, 1 S F 5s, '32	92	96
Buff & Susq. Iron, deb. 5s, '32	...	...
Cent. Found. 1 mtg. S. F 6s, '21	80	83
Col. F. & I., gn. S. F. 5s, '43	90	92
Ill. Steel, db. 4½s, '40	85⅝	86
Ind. Steel, 1 mtg. gtd. 5s, '52	96	96½
Lack. Steel, 1 5s, '23	97	98
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	93	95
Mid. St. & Ord., clt. cv. S. F. 5s, '36	89⅞	90½
Nat. Tube, 1 mtg. gtd. 5s, '52	98⅝	99
Rep. I. & S., S. F. mtg. 5s, '40	94¾	95
Tenn. C. & I. R.R. 'gn. 5s; '51	93	94
U. S. Steel, S. F. 5s. 63	100½	101
Va. C., I. & C., 1 5s. '49	86	88⅞

Published SEMI-MONTHLY *on the* FIRST *and* FIFTEENTH *of each month*

CHEMICAL
& METALLURGICAL
ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, August 1, 1919 *Number* 3

New Chemical Laboratory For Cornell University

AN UNNAMED donor has agreed to build a new chemical laboratory for Cornell University which shall be adequate to its needs. The University has been sorely crippled by the loss by fire of the major portion of its old laboratory, and unless present plans miscarry the new structure, which will cost over $1,000,000, will be ready for occupancy by the spring of 1920. This proper housing of the learned and able Cornell staff, and its body of students of chemistry, is a matter for congratulation on behalf of all who have the welfare of chemistry in America at heart. Speculation is rife among the alumni as to the benefactor's name, and while President SCHURMAN is firm in his silence in this respect, it is believed by many that CHARLES M. SCHWAB, or someone acting as his agent, is the likeliest guess.

Essential Qualifications for Commercial Agents in Latin-America

THERE came to us lately a request to recommend a competent man to travel in certain Latin-American countries with a view to securing information as to the needs of industrial establishments located in those regions. It was required of him that he be conversant with the language of the countries in question, and that he shall "know how to comport himself so as to gain the consideration and confidence" of the persons that he meets, in addition to having a broad understanding of a considerable list of manufacturing processes.

Now it is not difficult to find intelligent men who are familiar with the technical demands of such a position. But when it comes to finding such a man who is conversant with Spanish or Portuguese it becomes difficult. And when it is still further required that he "know how to comport himself so as to gain the consideration and confidence" of Spanish-American men of substance, the difficulty becomes greater still. This is not said in any sense of criticism of American technologists; it is merely a statement of fact based upon more or less local habits of life.

The white population of Central America and parts of South America is but a small minority and yet it is generally in control of the greatest business organizations. White domination such as prevails in our own Southern States is out of the question. For this very reason the white minority feels called upon to maintain habits of grace which are more or less traditional. It is demanded, for instance, as an index of good breeding, that everyone speak French with reasonable fluency. A certain familiarity with *belles lettres* and at least with classic art is expected. More or less ancient conventions are kept up. The obligation of good manners becomes a family tradition. They have what actors call "the grand manner." To those who are unaccustomed to it, it seems affected; but this, after all, is a matter of taste, and everybody, everywhere, is sensitive to criticism of his taste.

Now, many of our technical schools are so intensely practical that graduates often are not even on terms of amity with their own mother tongue, and those studies known as the humanities are passed by as useless. Modern languages also are neglected. Unusual dignity of bearing is frowned upon as lacking in democracy—and very possibly it is. What our South American cousins seek to demonstrate by the grand manner is not democracy; on the contrary, it is the outward and visible sign of their deference to ancient tradition.

The position of the South American person of circumstance, when a man from North America visits him, is that he would like to "get a line on him," as we say; to find out what sort of person he is. He may or may not know the name of the firm represented; the chances are, at all events, that he knows very little about it. The man who calls is his point of contact. If the latter makes a disagreeable impression he does not want any dealings with him. His business relations he also considers as social affiliations—which often confuses the man from the north. Agreeable persons from abroad are scarce, and they are greatly desired. He wants to deal with somebody who can understand him and his ways, including his likes and dislikes. Things that are negligible to the North American buyer become of leading importance to buyers from South America. Dates of shipment, metric units in packages, the size and shape of single packages, and many other details present themselves as more important even than the price to be paid—with in reasonable limitations. There are a thousand reasons why his unbidden visitor should be to him what he terms *simpatica.*

Again, if anything is thrown at a South American buyer with the statement that he can take it or leave it alone, the chances are preponderant that he will leave it alone. If the visitor lacks the time, or the inclination, or the wit, or the understanding to engage in a couple of hours of conversation, the host is unlikely to be interested in anything he has to say. He will be interested, however, the following week if a competitor who knows how to talk to him comes around. He is not ready to discuss business until he has had a chance to size up his visitor.

But suppose the Latin-American prospective buyer to be half or whole Indian, or suppose him to be tinctured by a strain of African—suppose him to be a man who does not even own a white collar; he will nevertheless set himself up to be a person of circumstance; he will assume that his tastes are similar to those of his white fellow citizens; and he also wants to size up his visitor before negotiations begin. He must know beforehand whether the prospective business connector can think as he does.

For the man who goes to South America to do business, a term at a commercial high school and a course in engineering are not enough. What he needs is polish, *savoir faire*, versatility and at least the semblance of grace. Then he can gain the friendship of the real men of substance and get their trade as well. And he can't get any trade worth seeking if he is a roughneck.

Pyrometers for Brass And Bronze Makers

TEMPERATURE control at various steps in brass and bronze manufacture is generally recognized as being most desirable, since it has been clearly demonstrated that intelligent melting reduces metal losses and heat consumption on the one hand and on the other promotes uniformity in the finished work. With the best will in the world, however, a logical application of present knowledge is difficult because durable pyrometers at once rugged and cheap are still unavailable.

Pyrometers would be very useful to give temperatures of metal in a furnace, and in the ladle; the one stationary, the other portable; both must be rugged. Furnace pyrometers would hardly pay except in furnaces of large capacity, especially if adequate portable indicators for metal in ladle were available. Apparently the most feasible furnace control known at present could be had by a gas-tight tube of graphite or some material which does not crack, dissolve or oxidize readily, this tube being raised during the charging and melting stages, then lowered into the bath and observed by an optical instrument. Such a device could be made extremely rugged, since there is plenty of time to overcome the lag due to heat capacity. It must be made of insoluble materials, however, since it must be arranged so it can be plunged into the metal—a tube in the furnace walls or anywhere else is worthless. Its use undoubtedly would save time and fuel, while giving minimum oxidation and absorption of gas.

Fortunately, modern electric-furnace design with its attendant greater control over temperature will reduce the need for a furnace pyrometer. Thus, on 24-hour operation a given number of kilowatts applied to a given charge for a given time will produce metal of the same temperature on successive heats, while on intermittent operation, the needed power input for each heat can be scheduled.

The second need, which will exist even when the first is solved, is for an instrument which will read temperatures in the furnace just before pouring or in the ladle. Here one must have not only speed but accuracy as well. One minute per ladle amounts to many hours per month; and one cannot wait long when deciding whether metal is just hot enough to pour certain castings without a misrun.

Speed means thermo-elements with small mass, which in turn eliminates refractory non-metallic protection tubes rugged enough to remain long in a foundry. Bare, base-metal couples will give speed, but practically all present analyses are rapidly corroded, and the readings are accurate only when the metal has an absolutely clean surface and is thoroughly mixed at the instant, since all the immersed portion is short-circuited and it is the temperature of the surface which is indicated. If there is a layer of slag, charcoal or oxide on the metal, the readings are scarcely more dependable than a judgment by eye—optical pyrometry clearly being inadequate.

Speed and accuracy call for metallic tubes of small mass—preferably of an insoluble alloy which could form one leg of the circuit, like the iron tube of the iron-constantan couple so satisfactory for aluminum. The choice of metal is not easy—in fact, it has occupied the attention of the Bureau of Mines alloy chemists for some time. It must have proper thermo-electric properties, it must not be brittle, it must be stiff and strong, it must be insoluble in hot alloys, and be capable of being drawn, cast or welded into thin-walled tubes. Nickel, either pure or alloyed, is very soluble; iron much less so. Pure chromium, molybdenum and tungsten are almost insoluble, but ductile molybdenum and tungsten oxidize just above working temperatures and are very expensive and hard to procure. A perfect chromium plating on a nickel tube would serve excellently, but a single pin hole or scratch ruins the tube. An alloy of 25 per cent chromium, 75 per cent iron, can be cast into moderately thin-walled tubes, but corrodes in rather an erratic manner. Heavy tubes of an iron-chromium analysis have been rather extensively used, but to cut down lag they must be constantly kept at about 1000 deg. C. in a separate furnace of small dimension.

Thus the metallic tube seems to be the crux of the problem—suitable couples and meters are now known. For standardization and experimental work quartz protection tubes were satisfactorily used by the Bureau of Standards, while Dr. GILLETT recommends a nickel tube protected by silfrax and tipped with a bare molybdenum nipple. Either of these has its obvious disadvantages and limitations when applied to work on the foundry floor and it is hoped that future research will bring to a successful end the large amount of admirable work already done on the problem of rugged pyrometers for use in brass and bronze. Eventually an insoluble dense alloy which can be drawn or rolled into tubes, or machined into closed end tubes of thin wall section will doubtless be found.

Declaration of American Policy Toward German Dyes

AT THE recommendation of the Advisory Committee on Dyes, the War Trade Board Section of the Department of State has issued a public statement of the policy underlying the present temporary control which is being exercised over the importation of German dyestuffs. On July 26 it was announced that, for the present, no licenses whatsoever are being issued for the importation of any dyestuffs produced or manufactured in Germany. The adoption of a permanent policy affecting the importation of dyestuffs is now being considered by Congress.

Licenses are being issued freely, however, for the importation of all dyestuffs produced or manufactured in non-enemy countries, especially Great Britain and Switzerland. Furthermore, under the provisions of Annex VI of Part VIII of the Treaty of Peace with Germany, which is printed on another page in this issue, German dyestuffs will become immediately available to American consumers under certain restrictions when the treaty comes into effect. Quantities will only be such as are necessary to meet domestic requirements, and prices will be fixed by the Reparation Commission. Nevertheless, as the result of a careful survey of the present situation in the dye-consuming industries and the unanimous opinion of the Advisory Committee on Dyes, there appears to be no such need for German dyestuffs in the United States as to warrant the issuance of licenses for their importation.

An earlier announcement of the War Trade Board Section on July 20 explained that vegetable dyes of natural origin may be imported without individual license.

The Shoe on The Other Foot

THE War Department announces that it is offering its surplus stock of platinum for sale at a minimum price of $105 per ounce. Purchasers may buy not less than 10 ounces or more than 1000 unless the Director of Sales deems it advisable to grant special permission for a sale of larger quantity. Incidentally we note that the Director of Sales has studied the market and method of disposition and has come to the conclusion that the scheme proposed will, as he says, "assure the Government the highest return for its surplus stock and at the same time prove most beneficial to the general public."

Without any intention of being uncharitable or cynical we cannot help recalling the situation of about a year ago when the War Industries Board arbitrarily set a price of only $90 per ounce on the platinum it confiscated, despite the fact that the market price for over a year and a half previous had been $105. Can it be that insult is now to be added to injury by offering back, to those from whom it was taken, the same metal at an advance of $15 per ounce? We fully recognize the fact that the present Director of Sales is not the War Industries Board; also that each may plead zeal in the Government's cause. Beyond that it seems evident that the patriotic citizen is asked to demonstrate the quality of his loyalty to the extent of taking a loss at both ends of the line.

Steel Production During the War

PRODUCTION of steel ingots and castings, in gross tons, has been as follows, beginning with the two pre-war years, easily the largest tonnage years in the industry before the war:

	Ingots	Castings	Total
1912	30,284,682	966,621	31,251,303
1913	30,280,130	1,020,744	31,300,874
1914	22,819,784	693,246	23,513,030
1915	31,284,212	866,824	32,151,036
1916	41,401,917	1,371,763	42,773,680
1917	43,619,200	1,441,407	45,060,607
1918	43,051,022	1,411,410	44,462,432

There was full operation of the steel industry from the late spring of 1912 until the late fall of 1913, and it was merely a coincidence that the ingot tonnages of the two years were almost precisely the same. There was some increase in capacity during the two years. There was no further increase in capacity until the latter part of 1915, while thereafter capacity increased rapidly, as to the making of steel, and as this increase was called for because of the demand for shell steel there was little tendency to increase finishing capacity, except in the one case of plates.

From a consideration of various details it may be estimated that capacity in steel ingots was about 35,000,000 tons in 1914 and is now about 49,000,000 tons, which would show a war-time increase of precisely 40 per cent. With production in 1912 and 1913 at less than the capacity at the end of 1913, and with production in 1918 interfered with by insufficiency of rail transportation, affecting in particular the supply of coke, and with other difficulties, it chances that the gain in production from 1912-13 to 1918 was 42 per cent, or almost precisely the same as the estimated increase in capacity from 1914 to the present time. In the production of steel castings there was approximately the same gain.

The production of rolled iron and steel in gross tons is shown in the table below. The system used in compiling the statistics is to take the material in its form after its last hot rolling (of course after shearing), whereby billets, sheet bars, etc., are not counted except when they are exported, and then of course they are counted at their weight when exported; rods are counted rather than rod billets or drawn wire, skelp is counted rather than pipe, black plate rather than tin plate, and so on.

	Rolled Steel	Rolled Iron	Total Rolled
1912	23,019,259	1,637,582	24,656,841
1913	23,112,986	1,678,257	24,791,243
1914	17,202,420	1,167,776	18,370,196
1915	23,098,091	1,294,833	24,392,924
1916	30,557,818	1,822,571	32,380,389
1917	31,199,943	1,867,757	33,067,700
1918	29,581,778	1,573,976	31,155,754

The increase in rolled steel production from 1912-13 to 1918 was 28 per cent, or much less than the 42 per cent shown for ingots. That, of course, reflects the large production of shell steel in 1918, with heavy cropping of the ingots. Evidently not as much was accomplished as was hoped for by the War Industries Board, in finding rolling uses for shell discard steel. Apparently the great bulk of the material became scrap, or else there was a large stock of ingots at the close of the year, for the proportion of rolled steel to ingots in 1918 was 69 per cent, against a normal of 76 per cent in 1912 and 1913.

The production of rolled iron decreased sharply in 1918 as compared with either of the two preceding years, while the production of ingots was much the same in the three years. The decrease in rolled iron was probably due in part to shortage of scrap, but in part also it was presumably due to lightness of demand. The strictly war demand ran almost entirely to steel and the railroads did not buy as much, either iron or steel, as in previous years. The 1918 rail production, for instance, was only 2,540,892 tons, or about 350,000 tons below the average of 1916-17 and 850,000 tons below the average of 1912-13, yet a large tonnage of rails went abroad in 1918.

The production of sheared plates, ¼-inch and heavier, amounted to 3,445,284 tons, against a production of 1,432,254 tons in 1913, showing an increase of 2,013,030 tons, or 140 per cent. A negligible tonnage of iron plates is included in the figures mentioned. As several of the new plate mills were not completed until late in 1918, the existing capacity is considerably greater than the production shown for 1918. No new plate mills will be needed for a long time.

The steel industry easily made good its promise in May, 1917, that the country would not be under the necessity of building wooden ships through inability to obtain steel plates.

Readers' Views and Comments

Flakes in Nickel Steel Gun Forgings

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the Rochester district during the past two years the Ordnance Inspection Office had considerable trouble with flakes in gun forgings made in that region.

Recently we reviewed all reports of physical tests on guns and classified the data contained. The results are especially interesting in that they compile the tests on approximately 4000 gun forgings in this summary.

Chart No. 1 shows that in forgings made from ingots cast during the months of January, February and March, 1918, over 50 per cent contained flakes. The percentage of flakes decreased continually after February, and the forgings that were cast in September, October and November showed no signs of this flaw.

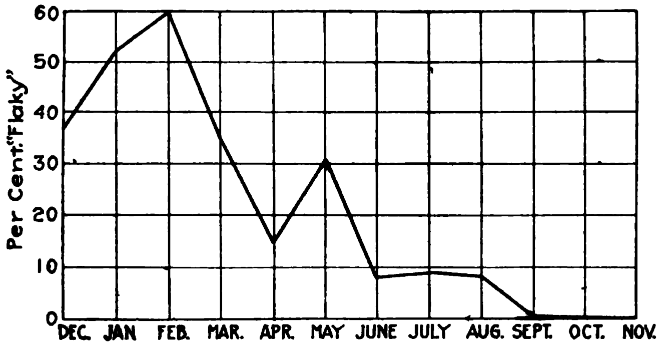


CHART 1.

Curve showing per cent of "flaky" forgings received from one steel plant. Date of casting used in classification. Figures based on results of 3500 forgings.

Chart No. 2 shows how the percentage of flakes varies with the nickel content. It will be noted that the tenderness of nickel steel and the tendency to flake increases quite rapidly with the nickel content up to 3 per cent.

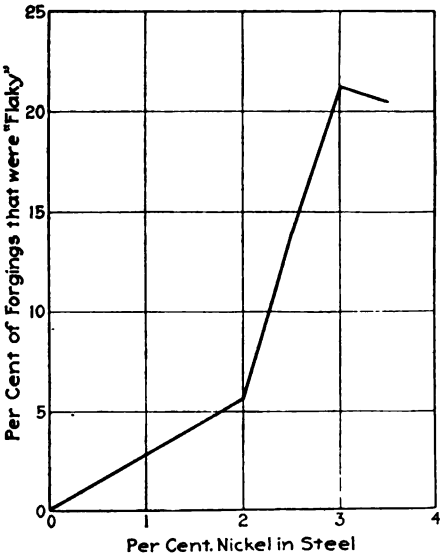


CHART 2.

All forgings with Ni content from 1.75 to 2.25 were grouped together in 2 per cent class. Per cent "flaky" obtained by dividing total showing flake by total in class. Same procedure followed to obtain per cents at 2.5-3.0-3.5 Ni. Figures based on average of 3000 forgings.

Practically all the forgings produced during January, February and March, 1918, contained 3 to 3.5 per cent nickel. After that time the percentage of Ni was decreased until the forging ingots cast in September, October and November, 1918, were made of either straight carbon steel or steel containing 1 per cent of nickel. A great deal more care was also taken in casting and forging as the seriousness of this flaw was realized.

Dr. H. M. Howe's theory of cracks forming either when the ingot is cooling or when it is forged seems very logical to me. The physical results obtained from test bars seemed the only argument against it. To settle this point in my own mind, I carefully measured the area of several flakes in different bars and subtracted this area from the original area of the bar. The figure thus obtained was the actual area of sound metal. I then divided this area into the load at elastic limit and tensile strength. It is to be noted that the tensile strength obtained in this way is not unreasonable in any case. Table I gives the figures for several bars.

TABLE I.

Physical Properties Based on Full Area				Physical Properties Full Area Minus Area of Flake	
Ultimate	El. Limit	Per Cent Elong.	Per Cent Red.	Ultimate	El. Limit
87,100	58,300	5.5	14.1	100,500	67,200
60,300	50,000	2.0	7.1	120,600	......
83,900	54,000	7.5	22.3	103,600	67,800
62,500	....	Double fracture		109,500	......
73,900	54,800	5.5	10.0	98,500	73,000
94,000	65,000	3.5	9.3	134,000	92,250
84,800	64,000	3.0	10.4	105,000	79,500
94,900	65,000	6.5	17.6	111,500	76,500
76,100	60,000	3.5	16.8	99,500	78,500
88,200	68,000	3.0	14.5	109,000	84,000
83,400	61,800	4.0	11.2	103,000	76,300
81,000	64,000	3.0	3.5	108,000	85,500
79,300	53,100	4.5	10.2	91,000	61.000
81,400	60,000	3.0	8.1	97,000	71,500
73.500	56,000	2.0	5.1	92,000	70,000

I feel that this trouble was due entirely to forced production and that it will disappear entirely now that the need of steel is not so great and more care can be taken in making the steel correctly. Flakes tended to form by heats. However, this was not always the case. Results indicate that the tenderness of the steel is dependent on the conditions under which the steel is made and thus varies from different heats.

RALPH A. HAYWARD.

District Metallurgist,
Rochester Ordnance Office,
Rochester, N. Y.

Electric Brass Melting

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I direct your attention to an error appearing in your issue for July 1, 1919, page 9, wherein you give the power cost for an electric furnace as 0.86 cent per kilowatt-hour. This figure would be correct if all of the 70,000 kw.-hr. used per month was charged to the electric furnaces; but as a matter of fact 20,000 kw.-hr. was used for lights or motors, leaving only 50,000 used directly by the furnace. Accordingly, the equation at the bottom of page 9 should be $602.5 \div 50,000 = 1.205$; also the first line on the top of page 10 should read "The electric furnace cost is 1.205 cents per kw.-hr., and in Table II. p. 10, the power price for the first case is 1.205 cents instead of 0.860.

X. Y. Z.

New York City.

Western Chemical and Metallurgical Field

Low-Temperature Distillation

A PROCESS for low-temperature carbonization which has attracted more or less notice in British Columbia has been experimented with at Nanaimo under the auspices of the inventor, Walter Thomas, and a Vancouver firm, McPherson & Fullerton Bros. Originally it was tried on Nicola Valley coal; the products were a semi-coked smokeless fuel, and about 7 gal. of oil per ton of fuel, with little permanent gas. Later work has produced a good dense charcoal from mill waste obtainable for a few cents per cord. In operation, a vertical brick-lined retort some 14 ft. high and 3½ ft. in diameter is filled with coarse material to be carbonized, then closed, and the air contained in the system forced by a fan through a pipe stove and into the top of the retort. This passes down through the mass to be carbonized, thence through a pipe condenser and an electrical precipitator to remove liquid hydrocarbons, and back to the fan for recirculation. As the carbonized fuel becomes hotter, gases will be given off so that after a time rich distillation gas should constitute the circulating medium.

Dr. Stansfield in his recent report on Electric Smelting of Iron Ore in British Columbia presents a short note on this process. He sees many drawbacks to the scheme as it was illustrated to him, such as the difficulty of forcing gas through the field retort, the slow heating of the carbonizing mass by the circulating gases, which are of low temperature and low heat capacity, the inefficiency and expense of the ordinary pipe stove, and the decomposition of hydrocarbon which will take place at this point. He has been assured, however, that enough work has been done to convince the backers of the process that they can make satisfactory charcoal at a cost of about $5 per ton, in a cycle of operations lasting six hours.

Magnesite for Flooring Composition

Magnesite trade has been generally very quiet since the signing of the armistice, marking time with the steel industry, the principal consumer. Refractory manufacturers absorb perhaps 85 per cent of the magnesite output in making brick and granular material for steel and copper furnaces, while the balance is used chiefly for flooring. For the latter, both caustic magnesite (carbonate burned down to 2 to 4 per cent CO_2) and a German magnesium chloride were used before the war. Recently, however, a scarcity of materials has raised the price of high-grade floor compositions to a point where their use is almost prohibitive.

The principal manufacturers of composition flooring have lately organized and instituted a co-operative research at the Pittsburgh laboratory of the Bureau of Standards to determine proper specifications for raw materials, calcination and method of laying the floor. It is hoped that the price can be brought into competition with that of hardwood flooring, when large quantities of it should be used.

As is well known, the principal American deposit is in Washington, where large-scale production is possible under most favorable manufacturing conditions. California deposits are more scattered and not well developed, and will consequently produce but little low-cost material. Argenteuil County, Quebec, has notable magnesite resources, having shipped 16,700 tons crude ore, and 22,700 tons of calcined material during 1918, of which 80 per cent was exported, mostly to the United States.

Iron and Steel in Canada in 1918

Canada produced 1,163,520 short tons of pig iron in 1918 from blast-furnaces, including those of the Dominion Iron & Steel Co., at Sydney, N. S.; the Nova Scotia Steel & Coal Co., at North Sydney, N. S.; the Standard Iron Co., at Deseronto, Ont.; the Steel Company of Canada, at Hamilton, Ont.; the Canadian Furnace Co., at Port Colborne, Ont., the Algoma Steel Corp., Ltd., at Sault Ste. Marie, Ont., and the Midland Iron & Steel Co., at Midland, Ont. This production was slightly less than in the two years preceding, but it was augmented by 30,425 tons of electric pig from steel scrap. mostly low-phosphorus pig from shell turnings. Such electric furnaces were operated at Hull and Shawinigan Falls, Que., at Orilla, Collingwood, St. Catherines, Toronto, Belleville, and Bowmanville, Ont., and at Port Moody, B. C. Ferros, chiefly ferrosilicon and a little ferromolybdenum and ferrophosphorus were made in electric furnaces to the extent of 44,700 tons, valued at $4,730,000, over half of which was exported. Practically all the pig iron was consumed in Canada, however, the amount being slightly increased by a net import of about 65,000 tons.

Steel ingots and direct steel castings amounted to 1,893,000 short tons, of which 73,000 tons were of the latter category. Both of these classifications show a considerable increase over the figures for 1917. Electric steel amounted to 120,000 tons, as compared with 50,000 in 1917 and 61 in 1914. Some 220,000 tons of steel products (exclusive of shell) were exported. Thus Canada is practically self-contained as to iron and steel products of ordinary use.

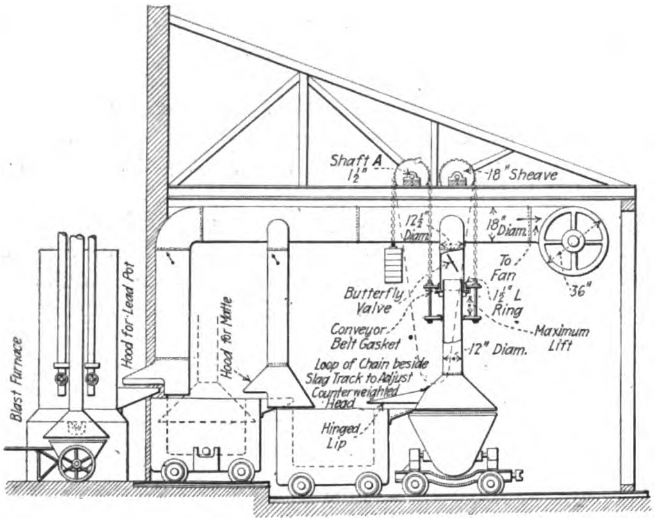
Electrometallurgical Research Laboratory in San Francisco

A laboratory designed to investigate problems arising in the electric smelting of various kinds of nonferrous ores has been added to the laboratories of the Beckman & Linden Engineering Corporation at San Francisco, and is now working on a nickel-copper ore which apparently will give a metal of similar character to monel metal. In view of the variety of mineral resources of the West Coast and the large amounts of hydro-electric power which will be available in years to come, the laboratory should prove to be of great help in promoting electrothermic reduction of ores in that region.

The equipment consists of complete electrical appliances to give 100-kw. single-phase current at a voltage range of from 40 to 120, together with proper switchboard and portable instruments for studying the electrical and temperature conditions during operation of a furnace. Semi-permanent furnaces will be erected as required by the study in hand, as is usual in research laboratories of this sort, an ample supply of leads, electrodes, refractories, ladles, molds, sampling equipment, and so on, being held in stock. In addition to this equipment, the laboratory is equipped with a 15-kw. low-voltage motor generator set, with the necessary accessories for studying problems in electrolytic decomposition and deposition.

Tapping-Floor Ventilators

"Safety-first" movements are responsible for the almost universal installation of ventilating hoods over forehearths and ladles around lead furnaces, for removing smoke perhaps more annoying than dangerous except at the lead well. Some of the installations work but passably, and tempt the furnaceman to neglect them, since they remove so little smoke as to be worth little trouble. He feels that he should not be asked to do anything except keep the lower part of the furnace in operating order, and such extra frills must be practically foolproof and automatic if they are to remain in operation. Even in the best installations which keep the tapping floor practically free from smoke, it is almost impossible to get workmen to close a damper in the matte-pan hood during the time it is not needed and thus save draft; if, on the other hand, stoppage of the fan throws the entire system out of order, they pour out of the building and vociferously demand more speed in repairing a condition they would have accepted as part of the job ten years ago.



SKETCH OF HOOD SYSTEM FOR LEAD FURNACE

Herewith are sketched some ideas observed in a successful hood system at a furnace using two forehearths in series. Since these crust over with chilled slag soon after being replaced, it is only necessary to hood the spouts and a small area where the slag enters. Furnacemen will keep these hoods somewhat high so that the outer air drawn in around the cages will not burn too quickly the wood placed on the spouts to keep them open, so extra clearance should be allowed at these places. One side of the hood at the furnace should also be cut back as shown, so that the tap-hole may be opened and closed without continual adjustment.

A complete system will involve hoods closely covering the lead pot, the matte pan and the slag pot, as well as two for the spouts to settlers No. 1 and No. 2. Each is closely counterweighted so it can be easily raised out of the way, by a rugged mechanism somewhat like that indicated, the lower pipe, smooth outside, telescoping into the upper part through a flap of conveyor belting, simple stops limiting the travel. Shaft *A*, for instance, is extended a sufficient distance to carry a guarded sprocket so that a loop of light chain can hang down to a handy point on the floor, easily reached and yet not interfering with ordinary furnace work. A like arrangement actuates a butterfly valve in each pipe, its position, whether open or shut, being shown by an arrow at the side of the pipe.

Exhaustion is effected by a fan capable of handling 6000 cu.ft. per min. per furnace; a draft of about 1½ in. at the fan will usually be sufficient. The very dilute smoke is discharged into the main blast-furnace flue, and the values recovered. As noted before, the fume rising from the lead pot is dangerous, the dense sulphur fumes from the matte pan quite irritating, while the mixed smoke from a slag stream is disagreeable from its volume and heat.

Exposition Plans and Exhibitors

THE Fifth National Exposition of Chemical Industries, which will be held in Chicago during the week of Sept. 22, promises to be of exceptional interest, since many of the inventions and developments made under the stress of war-time necessity will be shown publicly for the first time. As instances, we may mention: acid and alkali proof bronzes, prepared for specific purposes that even quite recently were unheard of; bronze of such hardness and strength that instruments made of it are used to cut chilled steel; technical organic products developed for waterproofing and fireproofing; instruments perfected during the war for precise measurements of temperatures, weights, volumes, velocities, flow of liquids, gases, electric currents, etc.

A feature of the exposition will be the exhibits of electric furnaces, which will include the Rennerfelt furnace, handled in America by Hamilton & Hansell; the Bailey furnace, by the Electric Furnace Co.; the Taylor furnace, by the Industrial Electric Furnace Co.; the Detroit Rocking furnace, by the Detroit Electric Furnace Co., the furnace of the Booth-Hall Co., and many others.

The Bureau of Mines will show the complete course of extraction of some thirty metals from their ores, together with the materials used in the extraction. In addition, the Bureau will have a collection of protective and safety devices, such as goggles, shields, masks, hoods, oxygen helmets, etc., and will hold a symposium upon "Safety in the Plant and Mine," with speakers of authority in this work, under the chairmanship of M. L. Leopold, safety engineer of the U. S. Bureau of Mines. In the evening after this meeting, which will occupy an entire afternoon, there will be shown a series of motion pictures of safety work in plant, field and mine—pictures now being made in industrial plants all over the country under the supervision of Government agents.

The Forest Products Laboratory of the Forest Service will make an exhibit of the work it has been conducting on processes, raw material, products, by-products, etc. Among the subjects will be the investigation on pulp and paper, ethyl alcohol from wood waste and sulphite liquor, the increased production of acetate of lime in hardwood distillation, and the naval stores investigations.

The Technical Association of Pulp and Paper Industry is planning an exhibit showing all the phases and stages in paper making from the tree to the finished paper, including illustrations of the machinery through which pulp passes in all stages.

The Bray Studios will endeavor to show, by means of animated drawings, the mechanism of certain chemical actions usually invisible to the eye and only conceived by the mind in abstract form. The following partial list of exhibitors indicates clearly the scope of the Exposition:

Abbe, Paul O.
Abbe Engineering Co.
Abbott Alkaloidal Co.
Abbott Laboratories
Ainsworth, Wm., & Sons
Albany Felt Co.
Alberene Stone Co.
Allen Electrolytic Cell Corp.
American Chemical Society
American Chemical & Mfg. Co.
American Ceramic Society
American Cyanamid Co.
American Electrochemical Society
American Hard Rubber Co.
American Kron Scale Co.
American La France Fire Engine Co.
American Limestone Co.
American Meter Co.
American Transformer Co.
American Water Softener Co.
Anaconda Copper Mining Co.
Angel H. Reeve & Co., Inc.
Aniline Dyes & Chemical, Inc.
Arkell Safety Bag Co.
Armstrong Cork Co.
Arnold Hoffman & Co., Inc.
Arzinger, W. O., Mchy. Co.
Austin Co.

Bachmeier & Co., Inc.
Bailey Meter Co.
Baker, J. T., Chemical Co.
Barrett Co., The
Bausch & Lomb Optical Co.
Beach-Russ Co.
Becker Christian Inc.
Beckley Perforating Co.
Beighlee Elec. Co.
Blackmer Rotary Pump Co.
Blair Campbell & McLean, Inc.
Bound Brook Chemical Co.
Boyer Oil Co.
Boyer Oil Mfg. Co.
Bristol Co., The
Brown Instrument Co.
Brown Portable Conveying Mchy. Co.
Buffalo Fdry. & Mch. Co.
Butterworth-Judson Corp.

Canada Carbide Co.
Canadian Chemical Journal
Canadian Electrode Co.
Canadian Electro Products Co.
Carborundum Co., The
Carnotite Reduction Co.
Carrier Engineering Co.
Celite Products Co.
Celluloid Zapon Co.
Central Scientific Co.
Challenge Co.
Chemical Construction Co.
Chemical Engineer
Chemical Equipment Co.
Chemical & Metallurgical Eng.
Chemical Catalogue Co., Inc.
Cleveland Cliffs Iron Co.
Clinchfield Products Corp.
Contact Process
Coors Chemical Porcelain Co.
Corning Glass Works
Crane Co.
Crane Packing Co.

Daigger, A., & Co.
Day, J. H. Co., Inc.
De Laval Separator Co.
Denver Fire Clay Co.
Detroit Electric Furnace Co.
Detroit Range Roller & Steel Bbl. Co.
Devine, J. P., Co.
Diamond State Fibre Co.
Dings Magnetic Separator Co.
Dorr Co., The
Dow Chemical Co.
Drackett, P. W., & Sons Co.
Duriron Castings Co.
Dunck Tank Works

Eagle Tank Co.
East Iron & Machine Co.
Economic Machinery Co.
Edgar Bros. Co.
Egyptian Lacquer Mfg. Co.
Eimer & Amend
Electric Furnace Co.
Electro Bleaching Gas Co.
Electrolytic Engineering Corp.
Electron Chemical Co.
Elmore, G. H.
Elyria Enameled Products Co.
Empire Laboratory Supply Co.
Engelhard, Charles
Everlasting Valve Co.

Fansteel Products Co., Inc.
Fibre Making Processes, Inc.
Fleisher, W. L., & Co., Inc.
Fletcher Works
Foamite Firefoam Co.
Foote Mineral Co.
Forest Products Laboratory
Foxboro Co., The, Inc.
Fuller Lehigh Co.

Gaertner, W., & Co.
Garrigue & Co., Wm.
Garrigues & Co., Chas. F.
General American Tank Car Corp.
General Bakelite Co.
General Ceramics Co.
General Chemical Co.
General Electric Co.
General Fire Extinguisher Co
General Filtration Co., Inc.
Glamorgan Pipe & Fdry. Co.
Glens Falls Mch. Works
Gordon Engineering Co.
Goulds Mfg. Co.
Groch Centrifugal Flotation Co.
Gruendler Patent Crusher & Pulv. Co.
Guernsey Earthenware Co.

Hamilton & Hansell, Inc.
Hanovia Chem & Mfg. Co.
Hauser Stander Tank Co.
Hardine Conical Mill Co.
Haynes Stellite Co.
Hemingway, Frank, Inc.
Hepworth Co., S.S.
Hercules Engineering Corp.
Hercules Powder Co.
Herold China & Pottery Co.
Hood, B. Mifflin, Brick Co.
Hooker Electrochemical Co.
Hoskins Mfg. Co.
Huff Electrostatic Separator Co.
Hunter Dry Kiln Co.

Industrial Electric Furnace Co.
Industrial Filtration Corp.
Innis Speiden & Co.
Irving Iron Works Co.
Irving National Bank

Jewell Polar Co.
Journal of Commerce & Commercial Bulletin
Journal of Industrial & Engineering Chemistry
Johnson & Carlson

Kenart Synthetic Products Co.
Kewaunee Mfg. Co.
Knight, Maurice A.
Knoxville Board of Commerce
Koppers Co., H.
Koppers Products Co.

Lead Lined Iron Pipe Co.
Leeds & Northrup Co.
Lindsay Light Co.
Liquid Carbonic Co.
Little, Arthur D., Inc.
Lungmotor Co.
Lungwitz, Emil E.

MacBeth Evans Glass Co.
Machinery Utilities Co.
Magnetic Mfg. Co.
Manufacturers Record
Marden Orth & Hastings Corp.
Mathieson Alkali Works, Inc.
McGraw-Hill Co., Inc.
Mead & Co.
Merck & Co.
Metals Disintegrating Co.
Miner, Edgar, Co.
Mineral Point Zinc Co.
Mojonnier Bros. Co.
Mott, J. L., Iron Works

Nassau Valve & Pump Corp.
Nash Engineering Co.
National Aniline & Chem. Co., Inc.
National Filter Cloth & Weaving Co.
Nelson, Alfred W., Co.
New Jersey Zinc Co.
Newark Wire Cloth Co.
Newport Chemical Works, Inc.
Niagara Alkali Co.
Niagara Electro Chemical Co.
Nitrogen Products Co.
Norton Co.

Ohio Pottery Co.
Oil, Paint & Drug Reporter
Oliver Continuous Filter Co.
Ontario Bureau of Mines
Organic Salt & Acid Co.

Parks-Cramer Co.
Pennsylvania Salt Mfg. Co.
Permutit Co.
Peterson, Leonard & Co.
Pfaudler Co.
Philadelphia Drying Mchy. Co.
Philadelphia Quartz Co.
Philadelphia Textile Mchy. Co.
Pneumercator Co.
Pratt Eng. & Mchy. Co.
Precision Instrument Co.
Precision Thermometer & Inst. Co.
Product Sales Co.
Provost Engineering Corp.
Pyroelectric Instrument Co.

Quigley Furnace Specialty Co.

Raymond Bros. Impact Pulv. Co.
Raritan Copper Co.
Redmanol Chemical Products Co.
Republic Flow Meters Co.
Research Corporation
Research Laboratory of Chicago
Revolvator Co.
Roessler & Hasslacher Chem. Co.
Rollin Chem. Co.
Rossendale-Reddaway Belting & Hose Co.
Ruth Co., The

Sarco Co., Inc.
Sargent, E. H., & Co.
Schaar & Co.
Schaeffer & Budenberg Mfg. Co.
Schutte & Koerting Co.
Schwartz Sectional System
Scientific Equipment Co.
Scientific Materials Co.
Scott & Co., Ernest
Semet Solvay Co.
Sharples Specialty Co.
Shawiningan Electro Metals Co.
Shawinigan Water & Power Co.
Sherwin Williams Co.
Sly, W. W. Mfg. Co.
Soderling, Walter, Inc.
Solvay Process Co.
Sowers Mfg. Co.
Sperry Co., D. R.
Star Brass Works
Stein Hall & Co., Inc.
Stokes, F. J., Mch. Co.
Stresen-Reuter & Hancock, Inc.
Sturtevant Mill Co.
Sullivan Machinery Co.
Sunbeam Chem. Co.
Swedish Crucible Steel Co.
Swenson Evaporator Co.

Tagliabue, C. J., Mfg. Co.
Tank Equipment Co.
Taylor Instrument Companies
Technical Products Co.
Texas Gulf Sulphur Co.
Thermal Syndicate Co., Ltd.
Thermo Electric Instrument Co.
Thomas, Arthur H., Co.
Thwing Instrument Co.
Tolhurst Machine Works
Tower & Wooden Tank Industrial Council

Union Sulphur Co.
Union Thermometer Co.
United Filters Corp.
United Lead Co.
United Lined Tube & Valve Co.
U. S. Bureau of Mines
U. S. Cast Iron Pipe & Fdry. Co.
U. S. Industrial Alcohol Co.
U. S. Industrial Chem. Co.
U. S. Stoneware Co.
U. S. Wind Engine & Pump Co.
Universal Oil Co.

Valley Iron Works Co., Appleton, Wis.
Valley Iron Works, Williamsport, Pa.
Van Schaack Bros. Chem. Works
Virginia Smelting Co.
Vitreous Enameling Co.

Wallace & Tiernan Co., Inc.
Wedge Mechanical Furnace Co.
Welch, W. M., Mfg. Co.
Wendnagel & Co.
Werner & Pfleiderer Co.
Western Reserve Chemical Co.
Westinghouse Elec. & Mfg. Co.
Whitall Tatum Co.
White, J. G., Engr. Corp.
Whitlock Coil Pipe Co.
Wilson-Maeulen Co.

Zapon Leather Cloth Co.
Zaremba Co.
Zavon, Inc.

Status of the Domestic Magnesite Industry

AT A tariff hearing before the House Ways and Means Committee on June 16 and 17, 1919, it was testified that before the war 95 per cent of the magnesite consumed in this country was imported from Austria and that since then most of it has been produced from mines located in California and in Washington State.

In 1914 the cost of imported dead-burned magnesite at Atlantic ports was between $16 and $17 a short ton, and the brick made from this material sold for $112 a thousand, 9-in. standard basis. The cost of dead-burned domestic magnesite, at the time of the hearing, at Atlantic ports was $49.10, and brick made from this material was bought for $400 a thousand. As much as $600 a thousand was paid during the war.

The amounts imported are shown in Table I and the domestic production in Table II.

The domestic magnesite is procured from deposits in California, where it occurs in an amorphous form in veins of varying size, and from deposits in Washington State, where it occurs in a crystalline form in large massive deposits similar to limestone. The development of the California deposits is shown in Table III. The Washington deposits were not developed until 1917. During the year 1918 two companies produced 105,175 short tons crude magnesite from the deposits located at Chewelah and Valley. The known reserves in this country are 8,000,000 tons, the deposits of southern Europe are estimated to contain between 120,000,000 and 130,000,000 tons.

The request of the producers for a protective tariff is incorporated in bill H. R. 5218 as follows:

> A BILL To provide revenue for the Government and to establish and maintain the production of magnesite and manufactures thereof in the United States.
>
> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That on and after the day following the passage of this act, there shall be levied, collected and

> paid upon the articles named herein, when imported from any foreign country into the United States or into any of its possessions, the rates of duties which are herein prescribed, namely:
>
> 1. Magnesite, commercial ore, either crushed or ground, three-fourths of a cent per pound.
> 2. Magnesite, calcined, dead burned and grain, 1¼ cents per pound.
> 3. Magnesite brick, 25 per centum ad valorem.
>
> SEC. 2. That paragraph 539 of the tariff act of Oct. 3, 1913, is hereby expressly repealed; and that so much of paragraph 71 of said tariff act and of any heretofore existing law or parts of law as may be inconsistent with this act are hereby repealed.

The testimony of the witnesses at the hearing is conflicting; consumers of brick made from domestic magnesite claimed it to be inferior to brick made from Austrian magnesite, the life of the domestic product being between 60 and 80 per cent of the foreign. H. F. Wierum, general manager of the American Mineral Production Co., at Valley, Wash., claimed that brick made from a dead-burned magnesite produced at his plant was equal to brick made from Austrian magnesite.

TABLE I—IMPORTS OF MAGNESITE CALCINED, NOT PURIFIED, FOR FISCAL YEARS ENDING JUNE 30, 1912-17, BY COUNTRIES, IN SHORT TONS

Country	1912	1913	1914	1915	1916	1917
Europe:						
Austria-Hungary	99,104	163,715	109,797	10,997	.....	.....
Belgium	25	....	11	......	.....	.....
Germany	689	2,412	912	307	.....	.....
Denmark	....	....	103	......	.....	.....
Greece	114	1,605	4,631	9,560	6,346	.....
Italy	....	....	22	688	.....	.....
Netherlands	2,410	4,508	4,717	2,706	235	.....
Norway	163	....	....	22	.....	11
United Kingdom:						
England	61	1	129	......	2	25
Scotland	....	....	64	242	593	833
North America:						
Canada	234	350	197	2,543	2,094	3,092
Mexico	81	....	....	......	.....	.....
South America, Venezuela	....	....	....	508	.....	.....
Asia:						
British East Indies	57	....	....	......	.....	.....
British South Africa	....	....	....	......	.....	2
Total	102,938	172,591	120,583	27,573	9,270	3,963

TABLE II—QUANTITY AND VALUE OF CRUDE MAGNESITE PRODUCED IN THE UNITED STATES, 1891-1918, IN SHORT TONS*

	Quantity	Value
1891	439	$4,390
1892	1,004	10,000
1893	704	7,040
1894	1,440	10,240
1895	2,220	17,000
1896	1,500	11,000
1897	1,143	13,671
1898	1,263	19,075
1899	1,280	18,480
1900	2,252	19,333
1901	3,500	10,500
1902	2,830	8,490
1903	3,744	10,595
1904	2,850	9,298
1905	3,933	$15,221
1906	7,805	23,415
1907	7,561	22,683
1908	6,587	19,761
1909	9,465	37,860
1910	12,443	74,658
1911	9,375	75,000
1912	10,512	84,096
1913	9,632	77,056
1914	11,293	124,223
1915	30,499	274,491
1916	154,974	1,393,693
1917	316,838	2,899,818
1918 (estimated)	225,000	....

* From *Mineral Resources*, 1914-17.

TABLE III—CRUDE MAGNESITE PRODUCED IN CALIFORNIA, 1913-17*

Year	Producing Mines	Quantity, Short Tons	Value
1913	1	9,632	$77,056
1914	6	11,293	124,223
1915	16	30,499	274,491
1916	45	154,259	1,388,331
1917	65	211,663	2,116,630

* From *Mineral Resources*, 1917.

The difference between the Austrian and the domestic magnesite is principally in the amount of hematite present.

At the Valley plant magnesite and hematite are ground to 200 mesh. After being thoroughly mixed in the proper proportion the mixture is fed into a revolving kiln 165 ft. in length. The temperature in the hot zone of the kiln is 2900 deg. F., which insures perfect fusion; the product is homogeneous. Material manufactured under these conditions has been produced since March this year, and brick made from this product has been as satisfactory as those made from Austrian magnesite. This plant seems to be the only one that has made an intelligent effort to produce a dead-burned magnesite which will produce a satisfactory brick, and it is probable that co-operation between the producer of dead-burned magnesite and the manufacturers of brick will lead to more satisfactory results.

Ways and Means Committee Acts on Tariff Bills

THERE is a safe majority among the members of the Committee on Ways and Means of the House of Representatives opposed to the licensing system. This fact developed at the first meeting of the committee to consider the evidence submitted at the hearings which had been conducted on various commodities which were most in need of safeguarding. The opposition to the licensing system does not extend to that suggested for the dyestuff industry, in which it is practically certain that a licensing plan must supplement the duty.

At its meeting, the committee reported favorably, without amendment, the bill introduced by Representative Timberlake, of Colorado, providing duties on tungsten. The rate of duty on crude tungsten, ores and concentrates, as provided by the bill, is $10 per unit. Metallic tungsten and the various tungsten products and salts, including manufactured materials containing tungsten, are to pay duty at the rate of $1 per lb. The vote on the bill was along party lines, with the exception of Representative Martin, of Louisiana, a Democrat, who voted with the Republicans. The Democrats favor the licensing plan, rather than a tariff.

The committee also reported favorably Representative Bacharach's bill providing duties on laboratory glass and porcelain ware, optical glass, scientific and surgical instruments. The rates of duty prescribed under the bill are as follows:

> Glasswares and porcelain wares, laboratory apparatus, and other apparatus and appliances wholly or in part of glass or porcelain, for use in the sciences or in analyzing or testing or for use in education, 60 per centum ad valorem.
>
> Optical glass in any and all forms of glass for use in optical instruments or for any optical purposes, and all instruments and appliances of any and all kinds containing parts of optical glass or used for optical purposes, finished or unfinished, 45 per centum ad valorem.
>
> Philosophical, scientific, and laboratory apparatus, utensils, instruments, and appliances and parts thereof, finished or unfinished, and preparations, including bottles and boxes containing the same, not otherwise provided for, 45 per centum ad valorem.
>
> Surgical and dental instruments, or parts thereof, made wholly or in part of iron, steel, copper, brass, nickel, aluminum, or other metal, finished or unfinished, 60 per centum ad valorem.

DYES, POTASH AND MAGNESITE STILL UNDER CONSIDERATION

The committee, at this writing, still has under consideration the dyestuffs bill and the potash bill, as well as that providing a duty on imports of magnesite. It is believed that the committee is likely to report out substantially the revised Longworth dye bill. In addition to specifying a free list and providing a rate of tariff for the dutiable list, the bill provides for a dye licensing commission as outlined in our issue for July 15, p. 65. The commission shall issue licenses for such dyes as may be unobtainable from domestic sources and shall limit importations as nearly as possible to quantities required by current needs in the United States.

One of the developments of the situation is that the Tariff Commission is very much opposed to administering any licensing system. It came to the ears of the Commission that it had been suggested as the proper body to administer the licensing machinery, and the result was that the Commission not only reiterated its opposition to most of the licensing suggestions, but emphatically urged that it not be selected to administer any of the licenses.

Dr. Hoyt S. Gale of the Geological Survey, in testifying this week before the House Ways and Means Committee, said that the German potash industry could not regain the position it held before the war. The increased cost of labor and the internal condition of the industry, he said, were such that German potash would have to sell for at least $1.50 per unit.

Dr. Gale returned to Washington last week from Europe, where he made a study of the potash industry, and it was at the special request of Secretary Lane that the Ways and Means Committee summoned him to testify.

W. E. Sharp, president of the Western Potash Works and of the American Potash Co. of Lincoln, Neb., denied to the Committee that the potash industry of this country was controlled by the packers. He admitted, however, that one company was owned by the packers, but said that the products of that company were used by the owners in the manufacture of fertilizer.

The hearings on potash and dyestuffs before the House Ways and Means Committee will not be resumed until after the House recess, Sept. 8.

International Exposition of Mining Industries

A permanent exhibit of mining and metallurgical machinery is to be established under the direction of the Merchants and Manufacturers Exchange of New York, which has taken over Grand Central Palace for the purpose of maintaining industrial exhibits of various kinds. Approximately 50,000 sq.ft. of space, or one entire floor, will be devoted to the machinery and supplies used in the development and operation of metal mines, non-metal mines, coal mines and oil wells; subsequent extraction or refining of the raw products by concentration, leaching, cyaniding, flotation, smelting, distillation, coking, etc.

The new enterprise enjoys unusual support in the backing of the Nemours Trading Corporation, of which Alfred I. duPont is president. The corporation owns and controls the Merchants and Manufacturers Exchange of New York and has branches in the leading cities of the world consisting of 19 branch offices and 3000 foreign selling agents. The purpose and function of the venture are to develop both foreign and domestic trade in all lines of industry and to establish at a central point a permanent exhibit of machinery and products for the benefit of foreign and domestic merchants.

The exhibit of mining industries will include aërial and surface transportation, laboratory appliances and supplies, blast-furnaces and other ore-treating equipment, compressors, crushers, concentrating machinery, hoists, drills, power machinery, ventilating equipment, etc. The exhibition will be under the direct management of Mr. Howard R. Ward, a mining engineer who prior to entering war work was for three years consulting mining engineer for the American International Corporation. The present headquarters of the International Exposition of Mining Industries is Room 421, 405 Lexington Ave., New York.

Peace Treaty Provisions Regarding German Dyes and Chemicals

The War Trade Board Section of the Department of State quotes, for the information of those concerned, the following provisions of the Treaty of Peace relative to German dyes and chemicals:

ANNEX VI

1. Germany accords to the Reparation Commission an option to require as part of reparation the delivery by Germany of such quantities and kinds of dyestuffs and chemical drugs as the Commission may designate, not exceeding 50 per cent of the total stock of each and every kind of dyestuff and chemical drug in Germany or under German control at the date of the coming into force of the Treaty.

This option shall be exercised within sixty days of the receipt by the Commission of such particulars as to stocks as may be considered necessary by the Commission.

2. Germany further accords to the Reparation Commission an option to require delivery during the period from the date of the coming into force of the present Treaty until Jan. 1, 1920, and during each period of six months thereafter until Jan. 1, 1925, of any specified kind of dyestuff and chemical drug up to an amount not exceeding 25 per cent of the German production of such dyestuffs and chemical drugs during the previous six months period. If, in any case the production during such previous six months was, in the opinion of the Commission, less than normal, the amount required may be 25 per cent of the normal production.

Such option shall be exercised within four weeks after the receipt of such particulars as to production and in such form as may be considered necessary by the Commission; these particulars shall be furnished by the German Government immediately after the expiration of each six months period.

3. For dyestuffs and chemical drugs delivered under paragraph 1, the price shall be fixed by the Commission, having regard to pre-war net export prices and to subsequent increases of cost.

For dyestuffs and chemical drugs delivered under paragraph 2, the price shall be fixed by the Commission, having regard to pre-war net export prices and subsequent variations of cost, or the lowest net selling price of similar dyestuffs and chemical drugs to any other purchaser.

4. All details, including mode and times of exercising the options, and making delivery, and all other questions arising under this agreement shall be determined by the Reparation Commission; the German Government will furnish to the Commission all necessary information and other assistance which it may require.

5. The above expression "dyestuffs and chemical drugs" includes all synthetic dyes and drugs and intermediate or other products used in connection with dyeing, so far as they are manufactured for sale. The present arrangement shall also apply to cinchona bark and salts of quinine.

German-Owned Chemical Plants Sold

The largest single day's sale of German-owned property was made at public auction on July 18 by the Alien Property Custodian. The sale of three chemical plants brought $4,419,980. The successful bidders were W. E. Coffin & Co. and the American Analine Products, Inc., of 80 Fifth Ave., New York.

The Roessler & Hasslacher Chemical Co., of 100 William Street, New York City, with plants at Perth Amboy, N. J., and St. Albans, W. Va., was bought in at $505 a share. The stock of the Niagara Electro Chemical Co. sold at $4000 a share, the total price being $440,000. The concern has offices at 100 William Street, New York, and plants at Perth Amboy, N. J., and Niagara Falls, N. Y. The Perth Amboy Chemical Co. stock went for $940,800, or $480 a share.

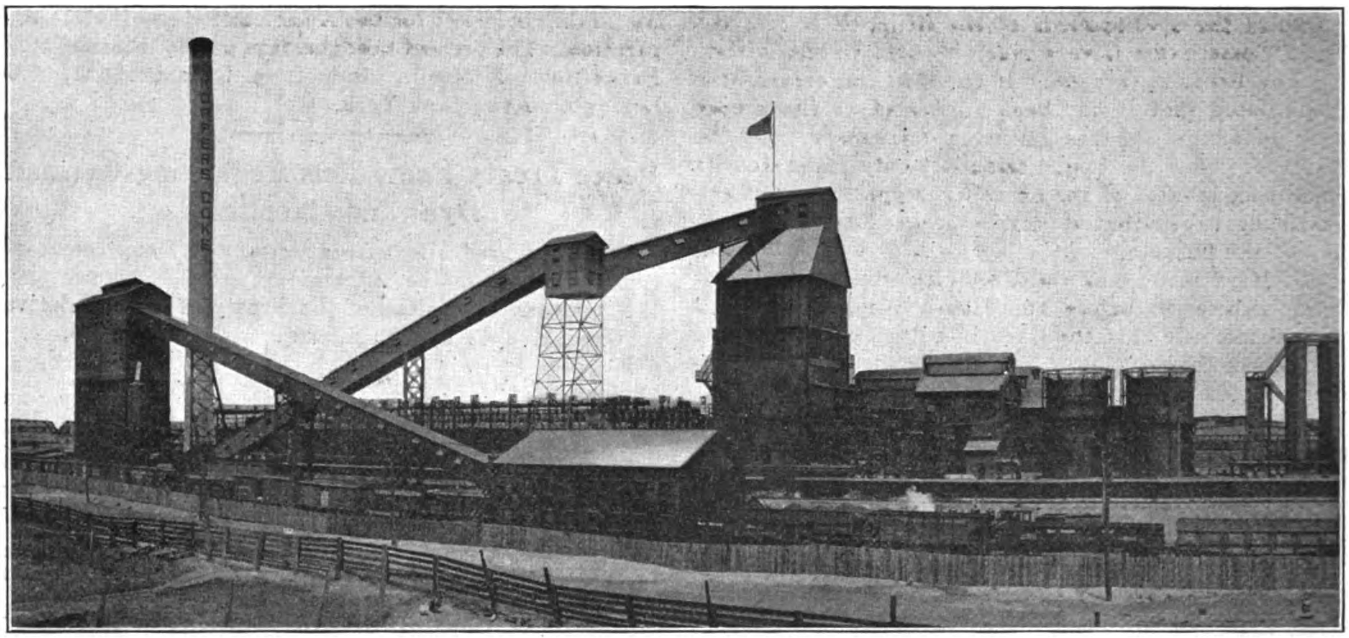


FIG. 1. GENERAL VIEW OF PLANT OF MINNESOTA BY-PRODUCT COKE CO., ST. PAUL, MINN.
From the left are: Coal crushing tower, stack, housing for inclined coal conveyor from coal dumping building in center foreground to top of the coal crushing tower, housing for inclined coal conveyor from bottom of coal crushing tower to top of coal storage bins at end of Battery B, from which bins the larry car is loaded with coal to be charged into the ovens. In the left-hand background are the two batteries totaling 65 ovens. To right of battery storage bins in order are: By-product buildings, rich and lean gas holders, final gas coolers and light oil scrubbers.

The Coking of Illinois Coal in Koppers Type Oven[*]

An Operating Test at the St. Paul Plant of Minnesota By-Product Coke Company Conducted Jointly by the National Bureau of Standards and the United States Bureau of Mines for Coking Orient, Franklin County, Ill., Coal

By R. S. McBride[†] and W. A. Selvig[‡]

THE great importance during the war period of substituting Mid-Continent coal for coals from more distant sources even in by-product coke-oven work was well recognized. The Bureau of Standards was ordered to conduct an investigation of a new coke-oven process claimed to be especially suited to this purpose, and in connection with this the Bureau was requested to conduct a test of the St. Paul plant of the Minnesota By-Product Coke Co., which is owned by the Koppers Co., Pittsburgh. The Bureau of Standards, in co-operation with the Bureau of Mines, carried out this operating test, using during 7½ days about 7700 tons of coal from the Orient Mine, Franklin County, Illinois.

The plant is usually operated with a mixture of Pittsburgh, Elkhorn and Pocahontas coal at normal coking times of about 16 and 17 hr. The normal capacity of the plant is approximately 1100 tons of coal per day. For the test period only Orient coal was used. Since the coking time for this coal was slightly longer than for the usual mixture, the capacity of the plant was reduced somewhat.

All phases of coal handling, by-product recovery and laboratory tests were under observation by the staff of 37 Government engineers and chemists employed on the work. In addition, those in charge had the benefit of advice and comment from a considerable number of experts who are specialists in the field of coke-oven operation. The quantity of all coal used and of all by-products obtained was carefully weighed or measured at regular intervals and samples of each material were taken for analysis. The Bureau of Standards was responsible for the general planning and supervision of the test work. Its representatives made all observations of battery operation, high temperature measurements, by-product recovery, and chemical laboratory work on gas and by-products. The Bureau of Mines was responsible for the sampling of the coal both as it was loaded at the mine and as crushed at the plant. It supervised the weighing, coal-handling, coke-handling and coke-sampling operations and made all analyses of coal and coke. Its representatives also made general observations on the character of the coke and operation of the ovens.

The Minnesota By-Product Coke Company plant consisted of 65 ovens, built with a gross regenerative system, operating during the test period with an average gross coking time of 19 hr. and 33 min., with coal finely pulverized, 12.75 tons per oven as charged. Each oven was 39½ ft. long, 9½ ft. high, 17 in. wide at the pusher side and 19½ in. at the coke side, making a 2½-in. taper with an average width of 18¼ in. The coke was

---

[*] This is an advance publication in abbreviated form of Bureau of Standards Technologic Paper No. 137. Published by permission of the Directors, Bureau of Standards and Bureau of Mines.

[†] Engineer chemist, Bureau of Standards.

[‡] Assistant chemist, Bureau of Mines.

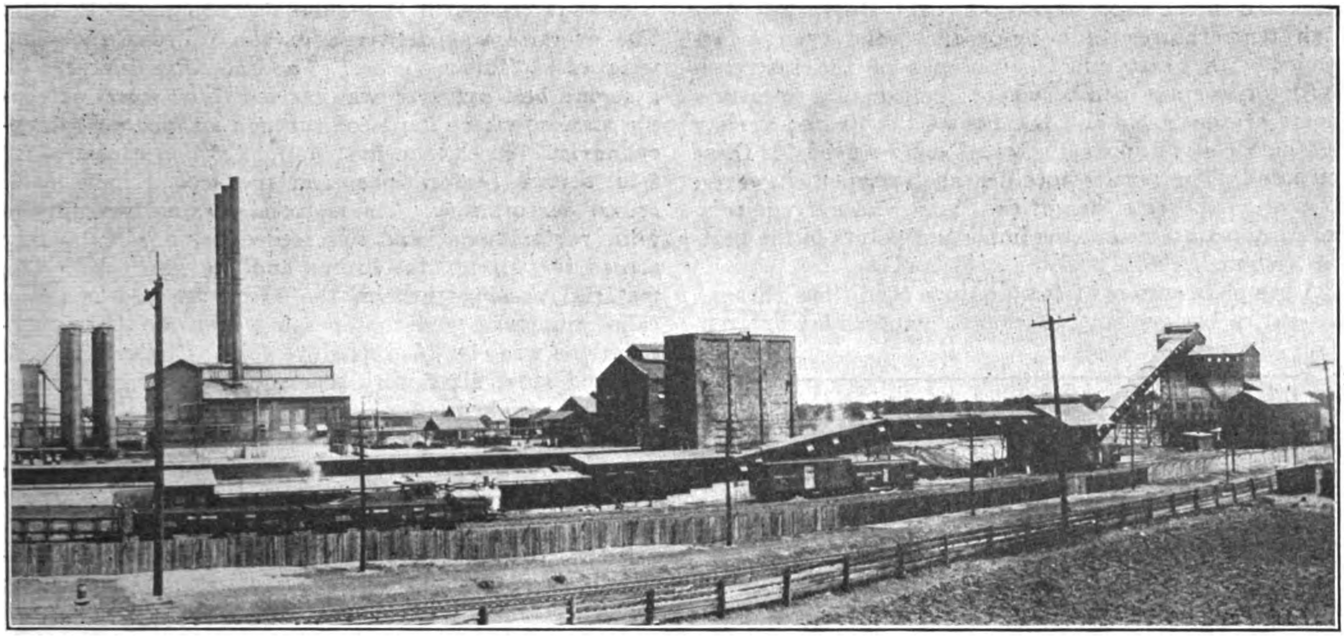


FIG. 2. GENERAL VIEW OF PLANT (CONTINUED)

In the foreground from left to right are shown: Coke wharf, housings for the coke conveyors, the first screening station where large furnace coke is separated from run of oven coke, and the housing for the inclined coke conveyor to final screening station, where the coke is further separated into small furnace and domestic sizes. In the background are the final gas coolers and light oil scrubbers, shown also in Fig. 1, the power plant, laboratory, complete light oil refining buildings, and coke-quenching station.

discharged from the ovens by the usual style of ram pusher into the common form of hot coke car and quenched in a tower of the usual kind. After discharge on the wharf it was handled by a typical conveyor system through two screening stations. The coke was screened to produce large and small furnace sizes; stove, nut and pea, domestic sizes and breeze. The gas was separated into rich and lean at the battery. Separate test records were kept of each size of coke and of each quality of gas. Practically all of the ammonia produced was made up into sulphate immediately through the direct recovery process. Although the plant operated for the production of pure light-oil products, only the total production of light oil was measured, but the yield of various constituents was determined by analysis.

COAL USED

The coal was apparently clean and very well screened. The impurities consisted of a small amount of pyrite, mostly in the form of thin layers, calcite, mother of coal, and shale. The coal was crushed at the plant with the intention of making it as fine as was feasible with the apparatus available. As charged to the ovens, over 95 per cent passed through a 4-mesh sieve, and about two-thirds passed through a 10-mesh sieve.

A composite sample of the crushed coal sampled from the conveyor belt was made up from the daily plant samples and analyzed according to the laboratory methods described in Bureau of Mines Technical Paper No. 8; the results are presented in Table I.

In Table II is given the total amount of coal used and the average coking time for the period of the test.

PUSHING AMPERAGE

No consecutive record was maintained of the current necessary to push the oven charges. However, sufficient data were obtained to show that, in general, the charges pushed easily, though not as easily as with the usual coal mixture. It generally required from 180 to 250 amp. to start the charge and from 120 to 180 amp. to keep it moving; in an occasional oven the amperage required to start the charge amounted to from 300 to 350, with 200 to 300 amp. required to keep it moving. Very few of the charges stuck, so that it was impossible to push the charge out before the circuit breaker acted; as high as 550 amp. was noted in one or two of these cases. One charge in particular, oven No. 49, on Sept. 29, gave a great deal of trouble; three attempts were made to push the charge before it was possible to clear the oven. However, in no case was it necessary to rake or dig the coke from the ovens.

TABLE I—COAL ANALYSIS AND HEATING VALUE

	As Charged	Dry Basis
Moisture	8.07%	....
Volatile matter	34.66%	37.70%
Fixed carbon	48.38%	52.63%
Ash	8.89%	9.67%
Sulphur	1.04%	1.13%
Hydrogen	5.32%	4.81%
Carbon	67.51%	73.44%
Nitrogen	1.49%	1.62%
Oxygen	15.75%	9.33%
Sulphur in fixed carbon from volatile determination	0.51%	0.55%
Heating Value:		
Calories	6,677	7,263
British thermal units	12,019	13,073

TABLE II—COAL USED AND OVEN OPERATION

Coal Used, in Tons:	
As charged	7,688.3
Dry	7,067.2
Ovens Charged	603
Coal per Oven, in Tons:	
As charged	12.75
Dry	11.72
Coking Time, in Hours and Minutes:	
Average gross	19:33
Average net	19:11

HIGH TEMPERATURE MEASUREMENTS

High temperature measurements were made continuously for several days during the test period in order to give an accurate idea of the operating conditions of the battery. Records were taken of the temperature in the oven walls, regenerators, waste-heat flue, in the coal mass and in the vapor above the coal. Measurement of high temperatures in a by-product coke oven is attended with great difficulty because of the inaccessibility of certain points where temperature measurements are desirable and because of the limited variety and high cost of apparatus which can be used for these purposes. The results obtained are sufficient, however, to give an accurate idea of the range and average temperature maintained at the important points in the heating system.

A complete survey of temperature conditions through the entire battery was, of course, impossible; but representative points were chosen and the results given in Figs. 3 to 6 inclusive are typical of all operations. During the period of the test certain optical pyrometer measurements were made by the company engineers which confirmed the fact that the locations chosen for our regular measurements were typical.

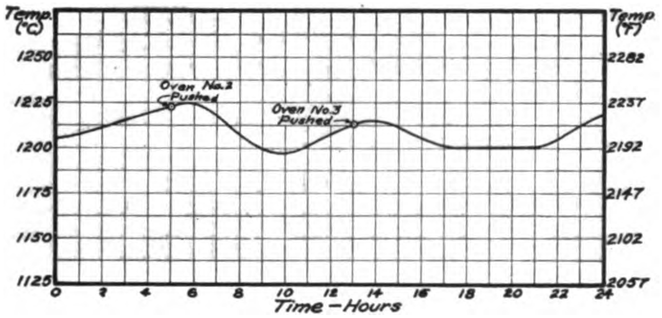


FIG. 3. AVERAGE TEMPERATURE OF HEATING WALL
Showing effect of charging and pushing temperature recorded 7 ft. below top of battery between ovens No. 2 and No. 3

The general trend of heating wall temperatures, before, during and after charging the adjoining ovens, is given in Fig. 3. These temperatures, of course, are not as high as prevail in certain parts of the wall refractory, for example at the lower regulating brick near the air port, where the maximum temperature is reached. To show the effect of gas and air reversal on the temperature in the heating wall, the curve of Fig. 4 is given.

Temperature measurements were made at three places in four consecutive charges of coal in oven No. 3. Readings were taken with couples 10 ft. long, introduced through charging lids as nearly as possible midway between the oven walls. The mean of the temperature-time curves for these locations is plotted in Fig. 5. Short thermocouples were introduced through the charging lid nearest the pushing end of oven No. 3 to measure the vapor above the coal. Four curves for four consecutive charges are shown in Fig. 6.

Over the checker-brick in the right half of the regenerator under oven No. 3 at the coke and 54 in. in from the face of the regenerator wall the temperature averaged 1140 deg. C. The variation in temperature during reversal of direction of gas burning was about 55 deg. C. at this point. Temperature measurements taken at the junction of the waste heat tunnels from the two batteries averaged 272 deg. C.

COKE HANDLING

During the test, two different systems of screening were used as follows:

Screening System No. 1—The coke was delivered by the conveyor over an inclined-bar-grizzly screen in the first station. The screen was about 5½ ft. long, 4 ft. wide and consisted of 1½-in. bars spaced from 1¼ to 1½ in. The oversize was delivered in the railroad cars and weighed as "furnace coke." The undersize delivered on a second belt conveyor was carried to a second screening station, where it passed through an inclined-rotary-cylindrical screen, the first half of which consisted of ¾-in. square perforations, and the second half 1⅜-in. square perforations. The material passing through the ¾-in. perforations was re-screened on a ½-in. shaker screen to separate the breeze and pea size coke. The material passing through the 1⅜-in. perforations was called nut coke, and that passing over the 1⅜-in. perforations was classified as stove coke. The breeze, pea, nut and stove sizes were separately loaded in railroad cars and weighed before shipment or storage. Nut and stove sizes, as delivered from their respective bins, passed over shaker feeders before going into the railroad cars. The pea and breeze sizes were thus very completely eliminated from these two domestic sizes.

Since the separation of "furnace coke" by the inclined-bar-grizzly in the first screening station was not considered satisfactory because the screen was not large enough to handle the quantity of coke passing over it and make a good separation, a change was made after three days of the test to the second system, which was as follows:

Screening System No. 2—The inclined-bar-grizzly in the first screening station was discarded and replaced by a 2½-in. rotary grizzly, the oversize of which was delivered directly into railroad cars as "foundry" or "large furnace" coke. The coke passing through the first rotary grizzly was carried to the second screening station, where it passed over a second rotary grizzly set at 1⅞ in. The oversize of this second grizzly was designated as "small furnace" coke. The material passing through the second grizzly was separated by the rotary cylindrical screen and sized exactly as in the first system. The furnace coke from the first system and both sizes of furnace coke from the second system, after being weighed, were stacked in a pile at the plant during the test period, so that they were subsequently available for a blast-furnace test as described later. The stove, nut and pea sizes were sold for domestic fuel, as is customary from this plant. The breeze produced was used as boiler fuel at the plant, following the regular practice.

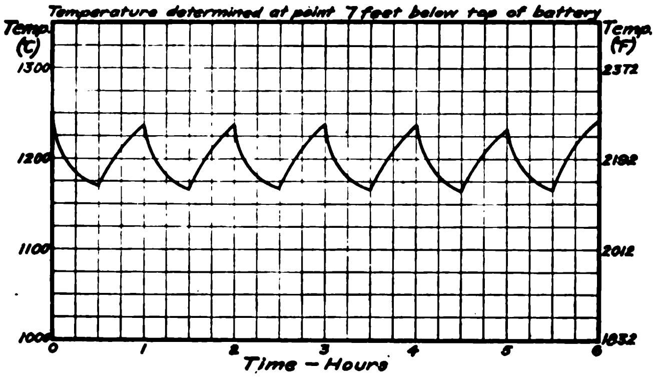


FIG. 4. TYPICAL HEATING WALL TEMPERATURE, SHOWING EFFECT OF REVERSALS

COKE YIELDS

Table III shows the different results obtained from the two screening methods. The results for the entire period are summarized together in Table IV.

It is to be noted that 82.7 per cent of the dry coke produced in screening system No. 1 was classified as furnace coke, oversize of the 1¼- to 1½-in. inclined-bar grizzly. As explained under description of screening system No. 1, the separation of the furnace coke by the inclined-bar grizzly was not considered satisfactory, as the screen was not large enough to make a good separation; the very high percentage obtained for furnace size is, therefore, not representative. The total dry furnace coke was only 40.3 per cent of the total dry coke screened during that part of the test when screening system No. 2 was used. However, it should be noted that the yield of stove size is very large, 34.8 per cent of the total coke as screened; there is no doubt that a large amount of the stove size would have been included in the furnace size if it had been possible to install a 1½-in. inclined-grizzly-bar screen large enough to handle the coke produced and make a good separation.

TABLE III—RESULTS WITH TWO SCREENING SYSTEMS

	Screening System No. 1, Per Cent		Screening System No. 2, Per Cent	
Furnace Sizes:				
Large	....		18.3	
Small	....		22.0	
Total		82.7		40.3
Domestic Sizes:				
Stove	6.7		34.8	
Nut	5.2		15.0	
Pea	0.9		2.4	
Total		12.8		52.2
Breeze		4.5		7.5
Total		100.0		100.0

TABLE IV—COKE YIELDS

Coke Produced (Dry):	Tons
Furnace	2,704.4
Stove	1,178.1
Nut	549.5
Pea	89.9
Breeze	308.4
Total	4,830.3
Ratio of Dry Coke to Dry Coal:	Per Cent
Furnace	38.3
Stove	16.7
Nut	7.7
Pea	1.3
Breeze	4.4
Total	68.4
Sizes of Coke Produced:	Per Cent
Furnace	56.0
Stove	24.4
Nut	11.4
Pea	1.8
Breeze	6.4
Total	100.0

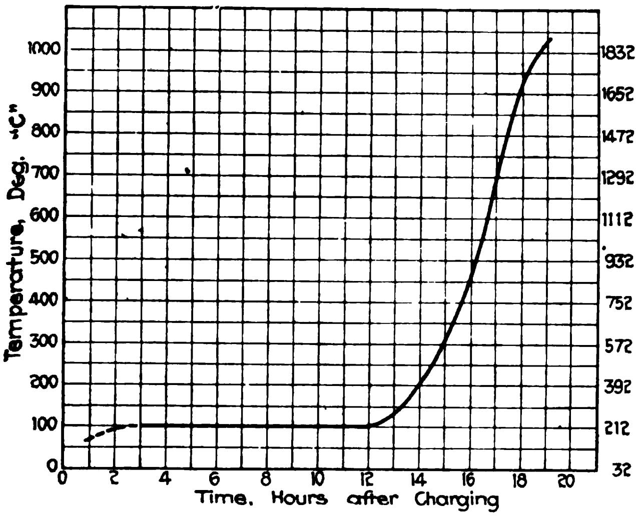


FIG. 5. AVERAGE OF COAL TEMPERATURE CURVES

The small percentage of large-size coke obtained together with the large percentage of the smaller domestic sizes indicated that it would not stand handling and screening without breaking up into smaller pieces, due to the fingery and brittle characteristics of the coke.

APPEARANCE OF HOT COKE

The hot coke as pushed from the ovens was observed in order to know the temperature and general performance of each oven and each lot was again observed after quenching and dumping on the wharf. By these observations a very complete idea of battery performance was obtained. These observations may be summarized as follows:

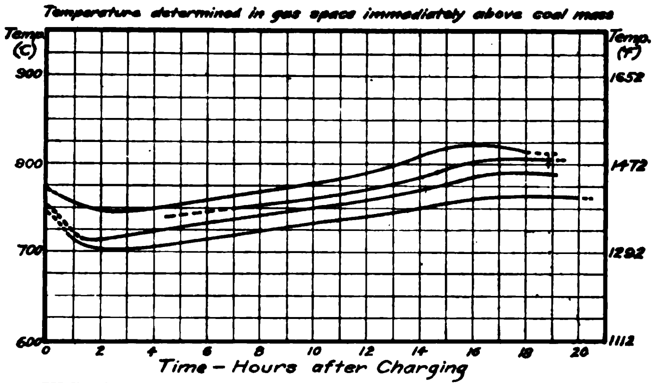


FIG. 6. TEMPERATURE OF VAPOR ABOVE COAL

The top of the coke mass was, as usual, colder than the rest of the charge. In fact this condition was somewhat exaggerated during the test, as it was impracticable to adjust the battery for the best use of the leaner gas from the Illinois coal when this was to be used for so short a period. From the level of the horizontal flue in the heating wall down to the bottom of the oven the coal was usually thoroughly coked; and in general the heats were uniform for the entire length of the charge. From a number of the charges some uncoked material remained in the center of the charge at the level of the horizontal flue.

From most of the charges a large amount of smoke and flame arose as the coke was pushed from the oven; this was especially noticeable in cases where uncoked material remained at the level of the horizontal flue. The overhang of the coke as it fell from the coke guide into the quenching car was irregular; on the coke side it ranged from 12 to 24 in., while on the pusher side the coke frequently showed signs of crumbling. Immediately ahead of the pusher ram the charge generally crumbled, thus causing a great deal of fine coke. A distinct line of cleavage was noted through the center of the charge in almost all cases.

APPEARANCE OF COKE ON WHARF AND IN CARS

The coke on the wharf was very irregular in size, but on the average the pieces were distinctly smaller than for the average by-product coke mixtures. There was no tendency to blockiness and very few pieces were as large as 6 in. in each dimension. The material was decidedly lighter than the average by-product oven coke, weighing only about 23 lb. per cu.ft. The color varied somewhat, but in general the furnace-size was of a dark silver color.

The coke had a decided longitudinal fracture and many of the pieces before reaching the wharf were broken up into fingers. Even the larger pieces showed a tendency to fingering, and by completion of the decided longitudinal fracture generally these broke up into several smaller pieces before reaching the cars. There was no apparent cross-fracture, but the brittleness of the long fingers was such that these frequently broke up into two shorter pieces during handling.

In the railroad cars the furnace size from screening system No. 1, in which a 1½-in. inclined-bar-grizzly screen was used, consisted mainly of small fingers from 1 by 2½ in. up to a maximum of about 2 by 6 in. There were very few blocky pieces about 2½ by 3½ in. The oversize of the 2½-in. rotary grizzly, used in screening system No. 2, in the cars was about half fingery and half blocky coke, averaging much larger than from screening system No. 1. The small-furnace size from this second system, through the 2½-in. but over the 1⅞-in. rotary grizzly, averaged about 2 by 2½ in. The great difference in size between the coke on the wharf and after loading in the cars shows the decided tendency to breakage during handling.

The cells of the coke were small and regular and in general of a structure indicating suitable characteristics for furnace use. There was no sponge formed, but there was a decided tendency to form a pebbly seam at a distance of 2 to 6 in. from and, in general, parallel to the oven wall. This seam appeared only in a part of the pieces in which it formed an incipient cross-fracture. In general there were no pebbly seams in the coke at the bottom of the oven. The small amount of pebbly mass noted seemed to come from the top and center of the oven in the form of small loosely-cemented lumps of material which were readily crumbled in the hands. Although the coal contained considerable "mother of coal," there was very little evidence of "foreign matter" in the coke, probably because of the fineness to which the coal was crushed.

COKE ANALYSES AND TESTS

Each size of coke was carefully sampled for analysis and for determination of moisture content in order to correct to true weight at the time it was loaded in the railroad cars.

The results of proximate and ultimate analysis and heating value determination of the composite sample of each size of coke are given in Table V.

TABLE V—COKE ANALYSIS AND HEATING VALUE

	Furnace Coke		Domestic Coke		Coke Breeze	
	As Loaded	Dry	As Loaded	Dry	As Loaded	Dry
Moisture	7.15%	....	11.51%	....	17.07%	....
Volatile matter	2.18%	2.35%	2.81%	3.18%	4.06%	4.90%
Fixed carbon	77.93%	83.93%	73.15%	82.66%	64.69%	78.00%
Ash	12.74%	13.72%	12.53%	14.16%	14.18%	17.10%
Sulphur	0.85%	0.92%	0.82%	0.93%	0.87%	1.05%
Carbon	77.81%	83.80%	73.47%	83.03%	65.68%	79.20%
Hydrogen	1.17%	0.41%	1.67%	0.44%	2.54%	0.77%
Oxygen	6.55%	0.20%	10.60%	0.41%	15.83%	0.79%
Nitrogen	0.88%	0.95%	0.91%	1.03%	0.90%	1.09%
Phosphorus	0.009%	0.010%	0.010%	0.011%	....	....
Heating Value:						
Calories	6,385	6,877	6,049	6,836	5,453	6,576
British Thermal Units	11,493	12,379	10,888	12,305	9,815	11,837

The weight per cu.ft. of furnace coke was determined on one car of large furnace coke and also on one car of small furnace coke. This was done by leveling the cars and making the calculations from the net weights of coke and the rated cu.ft. capacity of the cars.

Apparent specific gravity determinations were made on three composite samples of furnace-size coke and an average of these is given as representing the entire lot. A single composite was made up for the entire lot and the true specific gravity determined. The porosity of the coke was calculated from these results for apparent and true specific gravity. These physical properties of the furnace coke may be summarized as in Table VI.

TABLE VI—CHARACTERISTICS OF FURNACE COKE

Weight per Cubic Foot of Dry Coke:	
Furnace size from screening system No. 1	23.4 lb.
Large furnace size from screening system No. 2	22.8 lb.
Apparent specific gravity	0.88
True specific gravity	1.85
Porosity	52.4%

BLAST-FURNACE TEST

In order to test the behavior of the furnace-size coke produced from the Orient coal, arrangements were made to use about 1800 tons of this material in the blast-furnace plant of the Mississippi Valley Iron Co. The coke regularly used at that furnace is produced in Koppers ovens of the Laclede Gas Light Co., St. Louis, from a mixture of Elkhorn, Pocahontas (low volatile) and Illinois coals. The substitution of the Illinois coke for the regular supply was accomplished abruptly and continued without interruption throughout the ten-day period. Several experts were present during this test, and it was the unanimous opinion of these persons and of the blast-furnace operators that the Illinois coke had shown highly satisfactory results. However, it should be borne in mind that the furnace used for this test was of small capacity, and it is not certain, therefore, that the results in this case would be duplicated on a large-size furnace.

SPECIAL OVEN TESTS

In order to study the effect of lower temperature and longer time of coking, and to get some idea of the value of certain special coal mixtures, a few ovens were operated under different conditions than normal. The lower temperature trials were made in oven No. 1 during the period of the test by cutting down the quantity of gas burned in the heating walls of this oven. The special mixtures were made up at the end of the test period and tried out in one or more ovens.

Low Temperature Coking of Orient Coal.—Oven No. 1 was changed from its regular operating period beginning Oct. 1 and three charges of distinctly longer periods, 22¾, 23½ and 25¾ hr., were pushed on Oct. 3, 4 and 5 respectively. The temperature of this oven was from 50 to 100 deg. C. lower than the temperature of the remaining ovens in the battery. The coke from these special tests was very similar to that obtained from the same coal coked for the usual 19-hr. period in that the cell structure was not materially different and that there was the usual small amount of "foreign matter" and no sponge. However, the material as it lay on the wharf appeared decidedly larger and blockier and there was slightly less of the pebbly mass or pebbly seam. The blocks of coke were decidedly stronger, judged both by their action when handled and by the shatter test described below. The results of this special work at lower temperatures were very closely comparable with the results obtained at Dover, Ohio, when using the same coal in a narrower oven and coking at a corresponding rate, measured in inches of coke formed per hour. It is evident from these tests that stronger, larger coke will be obtained at the somewhat lower temperatures used in this work than at the temperature at which it was necessary to operate during the full test at St. Paul in order that the gas supply of the city would not be interrupted.

Mixture of Orient and Pittsburgh Coals.—In order to study the character of coke produced from a mixture of equal parts of Pittsburgh and Orient coals, a single oven was charged with this mixture. Oven No. 60 was charged 5: 30 p.m. Oct. 7 and pushed 11: 30 a.m. Oct. 8; the charge was 25,100 lb. The coke from this 18-hr. test was thoroughly coked, but the appearance on the wharf was not encouraging. There was decided longitudinal fracture, indicating the fingery tendency common to high volatile coals, but the coke was fairly tough. The cell structure resembled that of Orient coal alone, except in the upper central section of the oven, where considerable sponge was formed. There was no noticeable cross-fracture, but the irregular shapes showed that the breakage of the material in regular handling would probably be rather high. The pebbly seam so frequently noted in coke from 100 per cent Orient coal was not apparent in this single test; but the tendency of Pittsburgh coal to produce sponge was not counteracted by the mixture.

Mixture of Orient and Pocahontas Coals.—A mixture of 25 per cent Pocahontas and 75 per cent Orient coal was used in three ovens charged on Oct. 7 and pushed after approximately 17 hr. of coking. In each case the charge was about 25,200 lb. The coke produced under these conditions was blocky and on the average of large size, but the pieces were very irregular. There was no tendency to finger, but a decided cross-fracture was shown. The coke, although appearing soft, was unusually tough, as will be evident from the high percentage unbroken in the shatter test. The cell structure was irregular and the general appearance of the material on the wharf would have indicated under-coking, but the appearance while hot, as it was pushed from the oven, showed that this was not the fact. The very small percentage of fine material indicated that an unusually high percentage of furnace-size would be available from this mixture.

Shatter Test of Special Cokes.—In order to get a rough check on the relative strength of the different special cokes which were made, a shatter test was carried out on each of the samples. For this test a 50-lb. sample of large pieces of coke taken from the belt, none of which pieces would begin to pass through a 2-in. square mesh screen, was dropped four times from a height of 6 ft. onto an iron plate. The pieces of coke which following this test would not in any position pass through the 2-in. screen were weighed and their ratio to the weight of the original sample was taken as the "percentage unbroken" in results indicated below.

The usual foundry mixture, consisting of 30 per cent Pocahontas, 35 per cent Pittsburgh and 35 per cent Elkhorn coal, was found to give a result of 68 per cent unbroken by this test. The straight Orient coal coked for 19 hr. gave a coke of which only about 27 per cent remained unbroken by this test. The coke obtained from 22- to 26-hr. coking periods was somewhat stronger, ranging from 27 to 38 per cent unbroken. The mixture of 50 per cent Orient and 50 per cent Pittsburgh showed about 53 per cent unbroken, and the mixture of 25 per cent Pocahontas with 75 per cent Orient was strongest of all, with 74 per cent unbroken.

The above results are merely an indication and must not be taken as any accurate measure of the strength, since only a limited number of tests were made. Large irregularities are always found in this kind of testing and moreover this test is not strictly significant as to the strength of the material, since at the best it really gives an accurate measure only of the likelihood of breakage during handling.

BY-PRODUCTS AND GAS PRODUCED

The results obtained during six days from 8 a.m., Sept. 29, 1918, to the same hour Oct. 5, 1918, were used as the basis for by-product and gas results, since during this period only Orient coal was in use and the system contained only products from this coal. During this period 6092.3 tons of natural coal were charged to the ovens, equivalent to 5600.6 tons on the dry basis, and these figures are used in calculating the yield of tar, ammonium sulphate, light oil and its products, and gas, which are reported in the following sections.

TAR AND AMMONIA

During the test, daily inventory was taken of the quantity of the tar and liquor in stock, accurate weights and specific gravities of tar shipments were recorded, and other necessary arrangements made to permit accurate determination of the quantities of these materials produced.

It was the intention during the test to produce only ammonium sulphate and maintain the minimum practicable supply of ammonia liquor. However, a slight variation in the quantity of liquor at the beginning and end of the test inevitably resulted, and appropriate correction for this difference in inventory was made and appears in the record of results reported. Samples of the tar, liquor and sulphate were taken for analysis regularly, so that the quality as well as the quantity of these materials would be a matter of record.

TABLE VII—YIELD AND CHARACTERISTICS OF TAR

Tar produced, as measured, gal	47,560
Tar produced, dry (computed), gal	46,100
Tar, as produced, per ton of coal as charged, gal	7.81
Tar, dry, per ton of dry coal, gal	8.23
Water in tar, by weight, per cent	2.6
Specific gravity, as produced	1.187
Specific gravity, dry basis (computed)	1.192

TABLE VIII—YIELD OF AMMONIUM SULPHATE

Produced, scale weight, lb	155,510
Produced, pure, lb	151,100
Equivalent in liquor, start of test, pure, lb	15,920
Equivalent in liquor, end of test, pure, lb	34,700
Equivalent due to liquor increase, pure, lb	18,780
Total production, pure, lb	169,880
$(NH_4)_2SO_4$ per ton of coal as charged, lb	27.88
$(NH_4)_2SO_4$ per ton of dry coal, lb	30.33
NH_3 per ton of coal as charged, lb	7.19
NH_3 per ton of dry coal, lb	7.82
Average of NH_3 in ammonium sulphate produced, per cent	25.06

The sulphate delivered from the saturators into wheelbarrows was weighed as it was conveyed from the saturator room to the storage pile. The weight of sulphate produced daily varied largely in accordance with the amount of ammonia liquor accumulated or worked up into the sulphate during the day. From the measurement of volume, the temperature, specific gravity, and per cent of NH_3 by weight, as determined in the laboratory test, the pounds of NH_3 and the equivalent weight of $(NH_4)_2SO_4$ were computed for the initial and final inventories.

LIGHT OIL

The rich and lean gas produced at this plant are separately scrubbed for light oil recovery, but the light oil separated from the wash oil in the stripping stills is collected together. During the test period two sections of the light oil "running tank" were used on alternate days in order to permit careful measurement of each day's light oil production.

Table IX gives the total production of light oil for the six-day by-product period and the yield based on the analysis of the composite sample analyzed according to methods prescribed in Ordnance Publication No. 1800.

TABLE IX—LIGHT OIL YIELD AND ANALYSIS

Produced, gal	22,570
Composition:	Per Cent.
Boiling under 200 Deg. C. (Engler Flask)	84.4
Washing loss	5.7
Steam distillation residue	5.5
Benzene (Laclede still)	56.8
Toluene (Laclede still)	13.4
Solvent Naphtha (Laclede still)	3.5
Residue	15.1
Produced per Ton of Coal:	Gal.
As charged	3.71
Dry	4.03
Produced per Ton of Coal: (Per Cent under 200 Deg. C.)	Gal
As charged	3.13
Dry	3.40
Benzene per Ton of Coal:	Gal.
As charged	2.11
Dry	2.29
Toluene per Ton of Coal:	Gal.
As charged	0.497
Dry	0.540
Solvent Naphtha per Ton of Coal:	Gal.
As charged	0.130
Dry	0.141

TABLE X—GAS ANALYSIS

	Rich Gas, Per Cent	Lean Gas. Per Cent
CO_2	4.5	3.8
Illuminants	4.4	2.4
O_2	0.6	0.4
CO	11.0	12.4
CH_4	31.5	25.1
H_2	42.4	50.7
N_2	5.6	5.2
Sp.gr. (Air = 1)	0.476	0.437
H_2S (grains per 100 cu.ft.)	430	340

TABLE XI—GAS PRODUCTION

Coal Used:	Tons
As charged	6,092.3
Dry	5,600.6
Volume of Gas Produced:	M.Cu.Ft.
Surplus—Rich to City	31,982
Lean to boilers	1,440
Total surplus	33,422
To Ovens—Battery A	2,842
Battery B	29,015
Total to ovens	31,857
Total gas made	65,279
Gas per Ton as Charged:	Cu.Ft.
Surplus	5,490
To ovens	5,230
Total	10,720
Gas per Ton of Dry Coal:	
Surplus	5,970
To ovens	5,690
Total	11,660
Gas to Ovens (per cent of total)	48.8
Heating Value of Gas:	B.t.u. per Cu.Ft.
Rich	569
Lean	490
Heat in Gas per Pound of Coal as Charged:	B.t.u.
In surplus gas	1,550
In gas to ovens	1,280
Total	2,830
Heat in Gas per Pound of Dry Coal:	B.t.u.
In surplus gas	1,690
In gas to ovens	1,390
Total	3,080
Heat in Gas Used to Coke Coal, Per Cent	45.2

GAS

The gas produced at the plant was separated at the ovens into rich and lean, the quantity of rich gas being so regulated as just to supply the requirements for the St. Paul Gas Light Co., to which all of this gas is sold. The lean gas remaining was used for heating the battery, and, if there was any excess, for firing the boilers.

The average analysis and total production of gas for the six-day by-product test period, together with the yield per ton of coal and relative heating value calculations, are presented in Tables X and XI.

SUMMARY

As a result of the test it is clearly demonstrated that some of the Illinois coals can be coked in the "chamber-type" oven without radical change in operating methods for the production of coke which can be successfully used in a blast-furnace. However, it appears that the temperature at which Illinois coal should be handled for the production of the best coke is somewhat lower than the best operating temperatures for Eastern coals and moreover the speed of coking of the Illinois coal is somewhat less. The yield of gas and by-products from Illinois coal of the kind tested is excellent both in quantity and quality. Of course the coal tested in this case represents one of the best Illinois coals for coking purposes, being lower in ash and sulphur and otherwise superior to many from this field.

In general, the comparison of Eastern coking coals with those from the Mid-Continent field must be made upon an economic basis, since which source will be preferable depends altogether on local conditions which will affect the cost of the material and the relative expense of handling. These phases of the question have, however, not been discussed in this report.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance and co-operation of the engineers and chemists who were associated with them in this work, as well as that of Mr. T. G. Janney, manager, and Mr. K. G. Richards, superintendent, of the plant, and Mr. F. W. Sperr, Jr., chief chemist of the Koppers Co., all of whom did all in their power to make the work both pleasant and successful. Special acknowledgement is also made of the great assistance which Mr. I. V. Brumbaugh has given us in working up the datat contained herein and in preparing this manuscript.

Washington, D. C.

A. I. M. E. to Have Large Program at Chicago Meeting

From a technical point of view, the Chicago meeting of the Institute, Sept. 22 to 26, promises to be one of the most interesting in its history. The wealth of material in the line of technical papers for discussion is greater than has been offered for any previous meeting; upward of 150 papers have been submitted to the committee, who find it no small task to arrange a program to present this number with a minimum of conflicts among papers on allied subjects.

One of the excursions to be made by the Institute as a body during this meeting is to the LaSalle district. A special train in leaving Chicago early Thursday morning will take the members and guests to LaSalle, Ill., where automobiles will convey the different parties to the coal mines, cement works and zinc smelters. For the ladies, and others of the party not particularly interested in these industrial operations, the LaSalle hosts plan an automobile trip to Starved Rock.

The Economic Status of American Chemical Industry

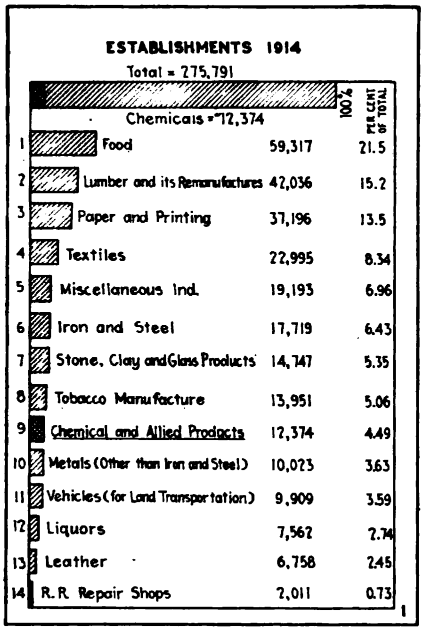
By Frederick E. Breithut
Major, Chemical Warfare Service, U. S. Army

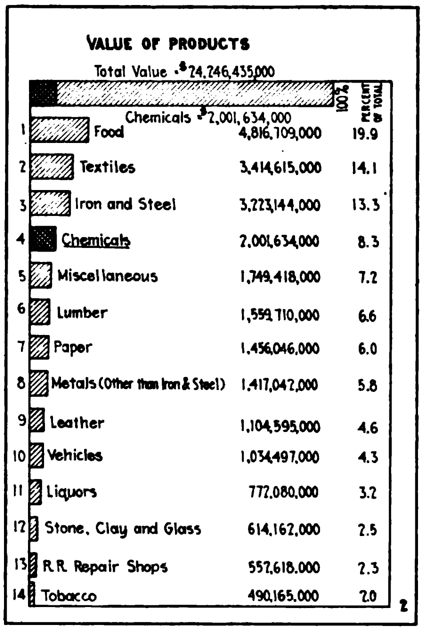
THE accompanying charts are based on the statistics given in the Census of Manufactures for 1914. They try to give some idea of the relation of chemical industry to the total of industry of the country.

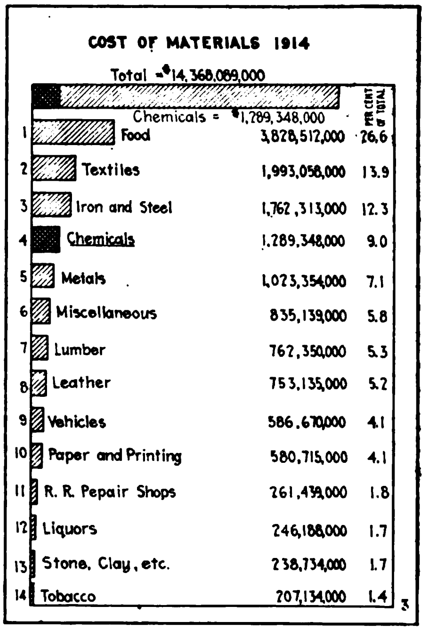
In endeavoring to present a picture of chemical industry as a whole one is immediately confronted with the difficulties of classification. The Census of Manufactures for 1914[1], for example, considers the group "chemical and allied products" as including "not only the industries whose products are chemicals in the ordinary sense of that term, but also the industries which employ to a large extent chemical processes in manufacture." In the introduction to the consideration of this group it is remarked: "The group is a very complicated one and the various products differ most widely in the character and in the use to which they are put. There is considerable duplication in the combined value of products for the group, due to the use of the products of certain industries as materials for others."

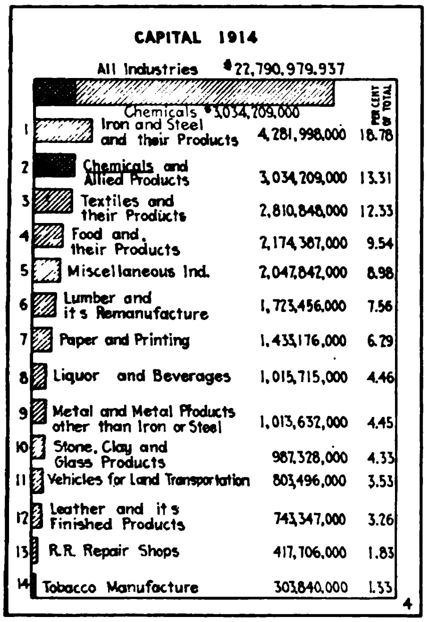
The Census of Manufactures for 1914 divides all manufactures into fourteen general groups as follows: (1) Food and kindred products, (2) textiles, (3) iron, steel and their products, (4) lumber and its remanufacture, (5) leather and its finished products, (6) paper and printing, (7) liquor and beverages, (8) chemicals and allied products, (9) stone, clay and glass, (10) metal and metal products other than iron and steel, (11) tobacco manufactures, (12) vehicles for land transportation, (13) railroad repair shops, (14) miscellaneous industries.

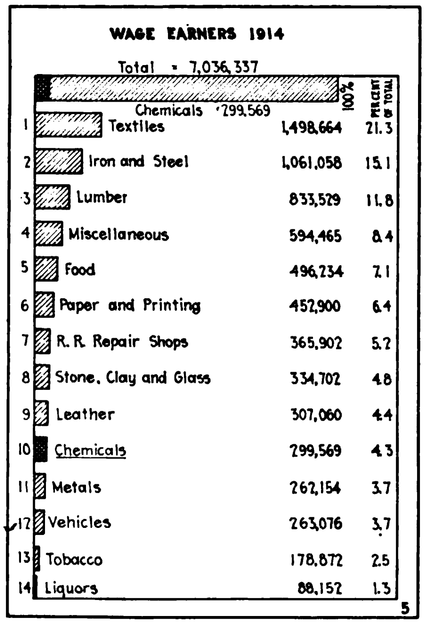
The group "chemicals and allied products" is subdivided in turn into twenty-four sub-groups, as follows: (1) baking powders and yeast, (2) blacking stains and dressings, (3) bluing, (4) bone, carbon and lampblack, (5) candles, (6) chemicals and acids, (7) cleansing and polishing preparations, (8) coke, not including gas-

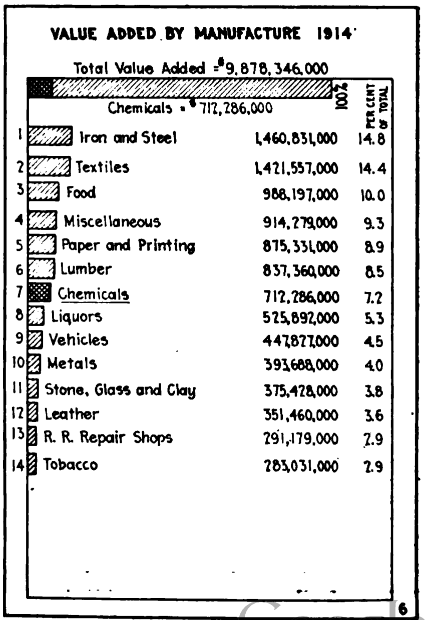






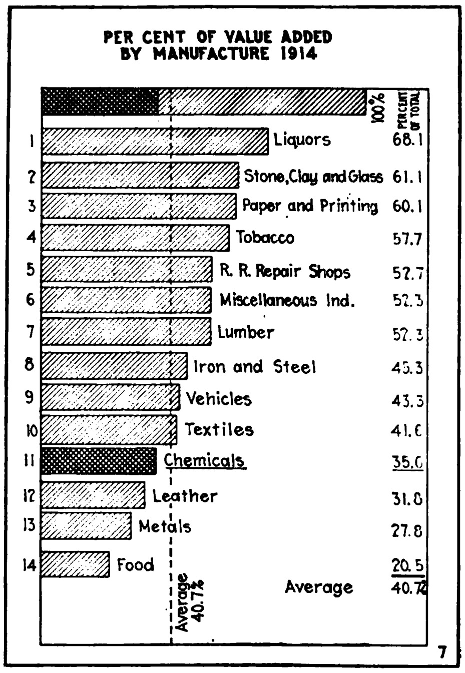






---

[1] Abstract of the Census of Manufactures, 1914. CHEMICAL & METALLURGICAL ENGINEERING, Vol. 19, 6a, pp. 371-386.



house coke, (9) drugs, etc., (10) dyestuffs and extracts, (11) explosives, (12) fertilizers, (13) gas, illuminating and heating, (14) glue, not elsewhere specified, (15) greases, (16) ink, printing, (17) ink, writing, (18) oils, (19) paint and varnish, (20) petroleum, refining, (21) salt, (22) soap, (23) turpentine and rosin, (24) wood distillation, not including turpentine and rosin.

Of these sub-groups, the item "chemicals and acids" is again subdivided into twelve parts, as follows: (1) acids, (2) sodas and sodium compounds, (3) potash and potassium salts, (4) alums, (5) coal-tar products, (6) cyanides, (7) bleaching materials, (8) chemical substances produced by the aid of electricity (including those belonging under other groups), (9) plastics, (10) compressed or liquefied gases, (11) fine chemicals, (12) chemicals not otherwise specified (such as glycerine, cream of tartar, epsom salts, blue vitriol, copperas, etc.).

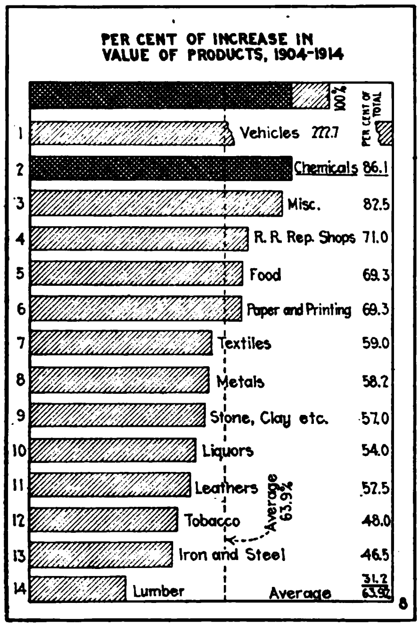
On the other hand, the monograph entitled "chemicals and allied industries" of the series issued on the basis of the Census of Manufactures for 1914 includes the twelve subdivisions just enumerated, and in addition fertilizers, paints and varnishes, explosives, dyestuffs and extracts, wood distillation, essential oils, bone, carbon and lampblack. To the busy man seeking information on chemical industry as a whole, or the relationship of a particular part of the industry to the whole chemical industry or to the industry in general, the picture is one of confusion. Under the circumstances it is only natural to find that dissatisfaction has been expressed concerning the present state of our chemical statistics. Thus Bernhard C. Hesse,[2] in 1915, presented a plan for a revision of our chemical statistics which resulted in the appointment of a committee of the American Chemical Society "to devise some practical and practicable way of obtaining such revision and of putting it into useful and serviceable effect." As chairman of this special committee of the American Chemical Society, Dr. Hesse[3] prepared a consolidated list of articles used or produced in or by chemical industries as they appear in the most diversified commercial reports.

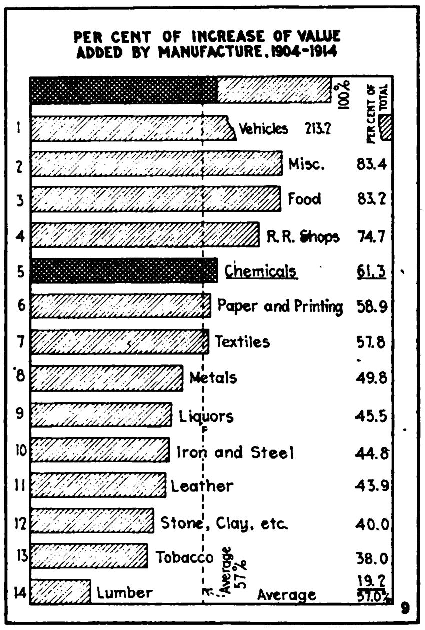
Accepting for purposes of comparison the data given in the 1914 Census under the heading "Chemicals and Allied Products" as related to industry as a whole, the charts shown herewith may be regarded as giving a general survey of the economic status of American chemical industry just prior to the outbreak of the world war.

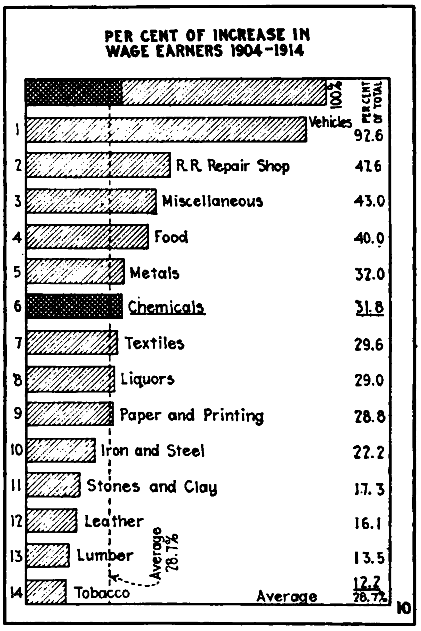
Chart I shows that of the 275,791 manufacturing establishments in the United States in 1914, 12,374 were engaged in chemical manufacture. This constitutes 4.49 per cent of the total establishments and places the group "Chemicals and Allied Products" in the ninth place in the order of number.

Chart II arranges the fourteen groups in the order of their importance from the standpoint of the value of their products. In this respect "Chemicals and Allied Products" ranks fourth, with a value of $2,001,634,000, constituting 8.3 per cent of the total.

Chart III shows the groups from the standpoint of







---

[2] *Jour. Ind. & Eng. Chem.* 7, 58.

[3] *Jour. Ind. & Eng. Chem.* 8, 749; METALLURGICAL & CHEMICAL ENGINEERING, Vol. XV, No. 3.

cost of materials entering into the industry, and in this respect "Chemicals and Allied Products" ranks fourth, with a value of $1,289,348,000, constituting 9.0 per cent of the total.

Chart IV arranges the groups in the order of their importance from the standpoint of capital[4] invested. In this regard "Chemicals and Allied Products" ranks second, with a total capital investment of $3,034,209,000, constituting 13.31 per cent of the total.

Chart V arranges the groups in the order of their importance from the standpoint of the number of wage earners. In this regard "Chemicals and Allied Products" ranks tenth, employing 299,569 workers, which constitutes 4.3 per cent of the total.

Chart VI arranges the groups in the order of their magnitude from the standpoint of the value added by manufacture. In this regard "Chemicals and Allied Products" ranks seventh, the value added by manufacture totaling $712,286,000, constituting 7.2 per cent of the total.

Chart VII shows the per cent of value added by manufacture for each of the fourteen groups. In this regard "Chemicals and Allied Products" ranks eleventh, with 35.6 per cent. (The average per cent of value added by manufacture for all industries is 40.7 per cent.)

Having shown the picture of the status quo of industry as a whole and of its large groups as it existed in 1914, an attempt was made to get an idea of the growth of these industries for the period 1904-1914. The results are shown in Charts VIII, IX and X.

Chart VIII shows the per cent of increase in value of products in the period 1904-1914. In this regard "Chemicals and Allied Products" ranks second, being exceeded only by "Vehicles," which includes automobiles. The per cent of increase in value of products is 86.1, which is much above the average for all industry (63.9 per cent).

Chart IX shows the per cent of increase of value added by manufacture in the period 1904-1914. "Chemicals and Allied Products" ranks fifth. The per cent of increase for chemicals, etc., in this respect is 61.3, which is a little above the average for all industry (57.0 per cent).

Chart X shows the per cent of increase in number of wage earners in the period 1904-1914. In this respect "Chemicals" ranks sixth, with an increase of 31.8 per cent, whereas the average increase was 28.0 per cent.

TABLE I. APPROXIMATE VOLUME OF BUSINESS IN 1914 AS COMPARED WITH 1917

Class	1914	1917
1. Coal tar crudes, intermediates, dyes	$25,000,000	$70,000,000
2. Drugs and pharmaceuticals	68,000,000	150,000,000
3. Essential oils, flavoring and perfumery materials	8,000,000	10,000,000
4. Explosives	41,000,000	500,000,000
5. Fertilisers	203,000,000	258,000,000
6. Heavy chemicals	39,000,000	177,000,000
7. Mineral acids	26,000,000	100,000,000
8. Miscellaneous inorganic chemicals	55,000,000	100,000,000
9. Miscellaneous organic chemicals	115,000,000	215,000,000
10. Natural dyestuffs and tanning materials	30,000,000	56,000,000
11. Paints and varnishes	149,000,000	175,000,000
12. Proprietary preparations	105,000,000	200,000,000
13. Soaps and glycerine	136,000,000	232,000,000
14. Wood distillation products and naval stores	35,000,000	76,000,000

The remarkable growth of American chemical industry under the stress of war has been the subject of much comment. An attempt to gage how great this growth has really been may be interesting. To this end the usual sources of information were consulted—trade journals, the files of the governmental bureaus in Washington, the manufacturers themselves. Table I shows the 1914 and 1917 figures for the more important chemicals.

---

[4] "The statistics of capital have been frequently referred to in the reports of previous censuses as defective, and in fact almost worthless, and it has been repeatedly recommended by the Census authorities that the inquiry should be omitted from the schedule. Experience at the census of 1914 confirms the belief that the statistics are of little value."—*Abstract of the Census of Manufactures*, 1914, p. 11.

The Explosion of Chemicals—II* Workmen's Compensation Acts

BY CHESLA C. SHERLOCK

IN our discussion of the liability of an employer to injured employees under the common law, we found that certain abuses had crept into the common law practice which made it practically impossible for an injured workman to recover damages for his injury. His right of recovery was limited to a very small percentage of the cases arising, and then his recovery depended upon his ability and resources sufficient to overcome his employer in a legal battle before the courts. The common law liability was founded entirely upon the theory of fault. Let the fault for the act be determined, and then the party at fault had the damages assessed against him. Only in a limited sense was this fault ever found to lodge entirely against the employer.

The narrowness of the common law soon gave rise to a spirit of unrest among the laboring classes and also among certain employers who had been forced to pay damages to injured workmen. These employers found that when a workman did recover he generally recovered an excessive damage, because the amount he was entitled to was left entirely to the whims of the jury So the demand came for a new system of liability which would eliminate legal controversy, definitely fix the employer's liability so that he could anticipate it and guard against financial loss by means of insurance, and at the time guarantee the payment of such damages to injured workman at the time when the damages were most needed.

The theory of the compensation acts is not based upon fault at all, but it is based upon the idea that all injuries suffered by accident in the course of the employment should be compensated. It is said that during his productive years the workman contributes to the wealth of society. Then, when industry contributes to rob him of his earning power by incapacitating him, society or industry should share the loss with him.

COMPENSATION NOT DAMAGES

Compensation is not in any sense damages. The compensation acts do not attempt to indemnify the workman for the actual loss sustained, but to merely share that loss with him. So we find that the compensation acts usually determine the amount of the loss sustained by the workman by ascertaining his average wages for the year next preceding the date of injury and then dividing that by one-half or two-thirds or whatever percentage the statute has determined the industry should bear and making that proportion the amount the employer shall pay.

The compensation acts go farther and absolutely deprive his employer of his common law defenses, so that it is practically impossible for the employer to delay or evade payment. They likewise deprive the employee of his common law rights, so that he can recover compensation and nothing more. Injuries that are reasonably common are set out in the act and the workman is allowed a specific number of weeks' compensation, so that he knows and the employer knows at once just the exact amount that is due. In other cases, particularly of temporary disability, the employer is to pay so long as the disability continues.

---

*The first article on this subject, on "Common Law Liability," appeared in CHEM. & MET. ENG., July 15, 1919, Vol. 21, No. 2, p. 83.

This is fair and just to both parties concerned. The employer in no case is called upon to pay an excessive judgment, as was formerly the case, and the payments are distributed over a number of weeks so that their payment will not financially embarrass him or throw him into bankruptcy. On the other hand, the workman is sure of getting his award and without the necessity of legal expense or a long protracted fight in the courts. The basis of recovery under the compensation acts is limited to those injuries causing incapacity through an accident arising out of and in the course of the employment.

It is not the purpose here to give an extended exposition of the decisions upon the compensation acts, as such would be impossible in the short space possible for this review of the matter. The question of what is an accident is pretty well settled at this time. The courts are practically united in saying that an accident is an unlooked for and untoward event happening within chance and without design or intention. They have said that under the compensation acts the term shall be given its ordinary and usual meaning and shall not be construed as employed in a technical sense.

ACCIDENTS MUST BE IN COURSE OF EMPLOYMENT

There is no doubt that an explosion of chemicals in the ordinary sense would clearly be termed as an accident under the compensation acts. But this is not sufficient to establish the employer's liability. The accident must arise "out of and in the course of the employment." If the workman is regularly engaged in the duties of his employment and is proceeding in a usual and careful manner and an explosion occurrs which clearly arises out of the employment of that particular workman, then he would be entitled to compensation.

But if the workman is outside the course of his own employment, even though the accident arose out of the general employment, he is not entitled to compensation. That is to say, if a workman is employed at his own task, but goes over to the bench of a fellow workman and meddles in his work so that an explosion takes place, he is not ordinarily entitled to compensation, because he is outside the course of his employment.

There are numerous decisions upon this point, but I think one will serve to illustrate the trend of the courts. A workman while on his way to a toilet paused at the bench of a fellow workman and commenced to play with some dynamite caps which the other workman used in his work. As a result there was an explosion causing the loss of several fingers and other severe injuries. He was not given compensation because he was outside the course of his employment at the time accident arose.

There are certain other limitations placed upon the employer's liability which it is well to keep in mind.

"HORSE PLAY" BARS COMPENSATION

If the workman is injured as the result of "horse play" or practical jokes on the part of other workmen he is not entitled to compensation, as it has been held again and again that horse play is not within the course of the employment. This is an unfortunate situation because the victim of the prank is nearly always innocent of any wrong doing, yet is made to suffer the burden of his fellow workmen's pranks.

While there is no legal liability imposed upon the employer in such cases, there is certainly a moral obligation imposed upon him to stop such practices as soon as he discovers them among his employees. If the employer goes to the trouble to tell his men just what happens in cases of injury and tell them of specific cases where harmless pranks have resulted in grave disaster, it will generally be sufficient to remove any chance of injury to innocent workmen.

If a workman is guilty of "serious and willful misconduct" and such misconduct is the cause of his injury, he cannot recover compensation. This generally refers to the manner in which he obeys his employer's instructions or the manner in which he does the work he is required to do. It would certainly be willful misconduct for a workman to willfully explode a charge of chemicals, even though he did it in a spirit of fun or experimentation. Unless such an act was clearly within the scope of his employment, he would not be entitled to recover compensation from his employer.

ANOTHER'S MALICIOUS INTENTION BARS PAYMENT.

The employer is not liable for the payment of compensation in cases where the workman is injured by the malicious intention of another. If two workmen get into a fight and one is injured through the malice of the other, no liability attaches to the employer. Furthermore, the employer is not liable under the compensation acts for the payment of compensation to casual workers, or those employed at casual work, such as window washers and those who are employed only for odd jobs at irregular intervals.

The employer generally is not liable for the payment of compensation to those who are not engaged in hazardous employment. He is not ordinarily liable to clerks and office help, or any one who falls within the clerical class, unless in the course of their work they are subjected to the hazards of the business.

The only way that the employer can determine his specific obligation under the compensation act is to refer himself to the statute under which he is operating. They vary in details in the respective jurisdictions. However, the main points given above are practically general rules in force wherever the compensation practice is followed, and they are supported by the great weight of judicial authority.

The compensation acts intend to exercise fairness and honesty among all classes and when they are administered in the true spirit they are a distinct improvement over the old common law system.

Glass and Glass Sand

In spite of the approach of national prohibition the demand for certain lines of glassware normally used in the dispensing of beverages to be banned has continued. In addition a new demand has arisen in unexpected volume for glassware to be used in the serving of soft drinks. This class of trade is now demanding an even better quality than was commonly sold for bar service. It is expected that soft drinks and near-beers will greatly increase in popularity and this new trade should eventually largely replace that lost in beer and liquor bottles.

The Nelson Electrolytic Chlorine Cell*

Development and Description of the Cell — Technology and Special Features: Simplicity of Structure, Graphite Anode, Durability, Floor Space, Attendance, Quality of Chlorine and Caustic and Electrical Efficiency

BY C. F. CARRIER, JR.†

SUCH a number and variety of electrolytic chlorine cells have been described in the patent and technical literature, or presented before the scientific societies from time to time, that it is with some diffidence we ask attention to this somewhat threadbare topic. Only some extraordinary feature would entitle a chlorine cell to a place on the program of the American Electrochemical Society.

Most chlorine cells have been introduced to the scientific world in their early patent or experimental stages, and many remarkable devices have been described and efficiencies claimed which for some reason have seldom materialized in practice. The Nelson cell is not a novelty of the hour, nor does it yield any theoretical results which have not been previously claimed for other cells, but surely the most extensively used chlorine cell in the world must possess some features of practical importance that are worthy of careful analysis, and we therefore give publicly for the first time a complete history, description and record of its commercial application. It has been the author's privilege to erect and operate three large plants using this cell, therefore the subject can be treated with intimate practical knowledge as well as with the co-operation of the inventor.

DEVELOPMENT OF CELL

This cell was developed by Mr. Harry R. Nelson of the Warner Chemical Co., at Carteret, N. J. It was the desire of this company to secure a supply of comparatively pure chlorine gas for use in the manufacture of chlorine chemicals other than bleach. With this aim in view, they began the production of chlorine about 1905 and it might be mentioned in passing that one of the oldest chlorine plants in the United States has been successfully operating for fourteen years on New York harbor with power that was not hydraulically generated.

The first installation consisted of McDonald cells[1]. These are essentially three-compartment cells. Two perforated metal cathode plates support the asbestos diaphragm and divide the cell into a middle anode compartment and two outer, or cathode, compartments. Graphite anode blocks with lead lugs were suspended from an earthenware cover box and the diaphragm was held in place by masses of cement concrete in the bottom and ends of the anode compartment. The cathode compartments were filled with caustic soda solution to about the same level as the brine in the anode compartment. Besides a very low ampere efficiency, this cell gave many operating troubles and the upkeep was excessive.

In 1908 it was determined to investigate the relative merits of mercury cathode and diaphragm cells. Mr. Nelson worked on the improvement of the diaphragm cell and the author developed a mercury cathode cell. As a result of these tests, it was decided by all concerned that the diaphragm type of cell was better adapted to the needs of the Warner Chemical Co. and further effort was directed to the improvement of the diaphragm cell. The McDonald cells were so materially altered that they completely lost their identity and a new cell was built which was the progenitor of the Nelson cell.

Much of the trouble with the McDonald cell was attributed to the use of concrete in the anode compartment. This was eliminated in the Nelson cell of 1908 by making the perforated metal cathode plate U-shaped and closing the ends of the anode compartment thus formed, by means of slate slabs. This was a great improvement, but the caustic compartment was still filled with caustic liquor and the ampere efficiency was still lower than was desired.

It was soon found that better results were obtained by leaving the caustic compartment empty and allowing the caustic and brine solution to drip from the diaphragm, but there was still some trouble due to decreasing percolation and increasing resistance as the operating period lengthened.

In 1913, these difficulties were overcome by the introduction of steam into the cathode chamber and the cell assumed the final form to be described below. This unique improvement was followed by the discovery of a process for treating the graphite anodes which more than doubled the life of the graphite, and later by the development of an automatic feeding device, details which will be discussed further below under "description" and "special features."

The culminating development has been during the period of the war, there now being in operation over

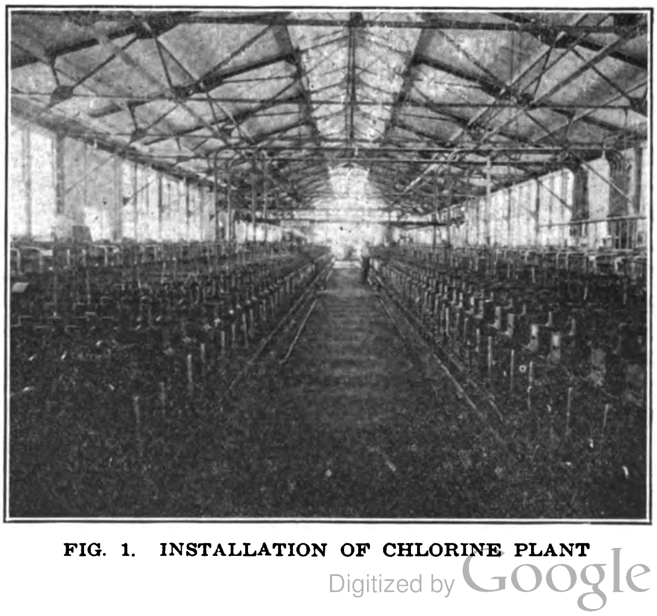


FIG. 1. INSTALLATION OF CHLORINE PLANT

---

*Extract of a paper read before the American Electrochemical Society, New York, April 3-5, 1919.

† American Cyanamid Co.

[1] U. S. Pat. 697,157, April 8, 1902.

twenty plants in various parts of the world. Nearly 8000 cells have been installed, rated at 1000 amperes capacity and representing a daily output of about 200 tons of chlorine gas. The largest single chlorine plant in the world is the United States Government plant at Edgewood Arsenal, Baltimore, Md., where over 3500 Nelson cells were installed for the production of 100 tons of chlorine gas per 24 hours. The construction of this plant was one of America's greatest chemical achievements during the war. It was built at a moderate cost, only 7 per cent above the estimates, which had not included overtime; it was ready to operate on the date promised and was completed without alteration of the plans after construction had been started. The other large chlorine plants of the world have been built in sections from time to time over periods of many months, while the Edgewood plant, the largest of them all, was entirely built in four months.[2]

DESCRIPTION OF THE CELL

A description of the cell is to be found in U. S. P. 1,149,210 of Aug. 10, 1915, but a much better idea of the general construction can be obtained from the accompanying illustration. Special attention is called to the simplicity of the design. A substantial, rectangular tank made of ¼-in. steel plate forms the body of the cell. In this is mounted a U-shaped cathode plate of perforated sheet steel, which also acts as the form for the anode compartment. The asbestos diaphragm is supported by the cathode plate and the ends of the U-shaped anode compartment are closed by blocks of cement mortar. An inverted, rectangular box formed of slate slabs closes the top of the anode compartment and also acts as a support for the graphite blocks which form the anode. The anode structure is so clearly shown in the illustration that it only remains to be said that the blocks are 4 x 4 x 17 in. and the lugs are 2½ in. diameter by 12 in. long. It is to be noted that there is but one joint in the graphite, thus insuring maximum conductivity. The positive terminal is connected by means of a flat copper bar bolted to the lugs of the anode blocks, while a copper plate riveted to the perforated cathode performs a similar service for the negative terminal.

The latest built cells, like the illustration, are operated with an automatic feeding device which is very simple and which has proved to be entirely reliable. It consists of a strongly buoyant float on which is mounted a dull knife edge which presses against a bit of rubber tubing through which the brine is supplied to the cell. The slightest rise of the float cuts off the feed entirely and the least drop permits the flow to start again. No trouble is caused by dirt in the brine, because all of the brine is purified before passing to the cells, it being quite essential in the operation of any electrolytic cell for chlorine manufacture that iron, alumina, lime and magnesia be substantially absent.

The brine percolates through the diaphragm and the rate of flow is kept uniform by means of an atmosphere of steam that is maintained in the cathode compartment. This steam also helps dissolve the caustic soda formed at the cathode as well as heating the cell and thus reducing the resistance of the cell. In case the pores of the diaphragm begin to close, as will be shown by excessively strong caustic liquor, they can be freed by increasing the amount of steam.

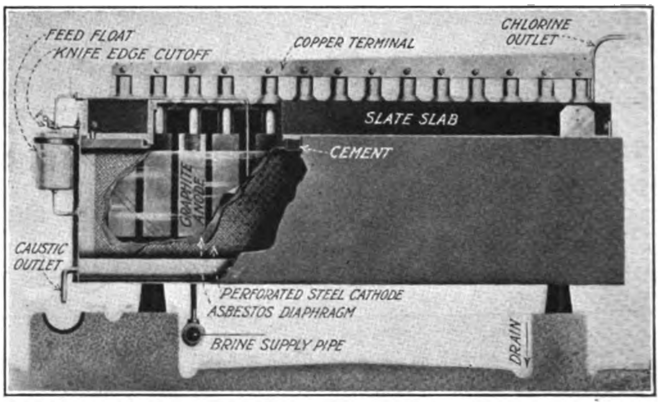


FIG. 2. NELSON CELL

The normal operating period between renewals of the diaphragm is from six to eight months and during this time the operating conditions remain practically constant. The cells are rated at 1000 amp., at which point the most efficient results are obtained, but they can be run as low as 600 amp. without serious loss of efficiency and will stand a continuous overload of 10 per cent without damage to plant or product. The voltage drop, averaging the switchboard reading and including all connections and cables, for a series of sixty cells, is from 3.5 to 3.8 volts and will usually average 3.7 volts over a period of six months. Only careless operation will cause an increase of more than 0.2 volt in the course of a six months' operating period.

The commercial guarantee under which these cells are sold specifies that, when operated at 1000 amp. and supplied with not to exceed 120 lb. of salt, each cell will produce 60 lb. of chlorine and 68 lb. of sodium hydroxide per 24 hours. For the first few days the caustic liquor flows very freely and is abnormally high in salt, but when the cells have reached normal working conditions the liquor will contain 10 to 12 per cent NaOH and 16 to 14 per cent NaCl.

TECHNOLOGY AND SPECIAL FEATURES

The normal operating period is six to eight months. At the end of this period it is considered better to renew the diaphragms and wash out the cells even if the operating conditions still seem very good, for they may become worse very rapidly if the period is stretched too far. The ordinary anodes are simply impregnated to prevent the electrolyte from creeping to the copper contacts, and only part of these will last more than two operating periods, that is, 12 to 15 months. A new process of treating the graphite has been perfected which increases the life of the anode to more than two years.

One of the greatest features of this cell is that it can be shut down either accidentally or intentionally for short or for long periods as often as desired without damage to the cell or serious loss of efficiency. To the best of our knowledge this is the only commercial chlorine cell that can stand frequent shut-downs without serious consequences.

Simplicity of Structure: Few, simple parts usually mean quick installation and low repair costs. The former was well illustrated at the Edgewood Arsenal plant and the latter has been borne out by the cost records of several large plants over long periods of operation. It also keeps down installation costs and operating expense, as it is possible to operate with ordi-

---

[2] See CHEM. & MET. ENG., Vol. 21, No. 1, July 1, 1919, p. 17.

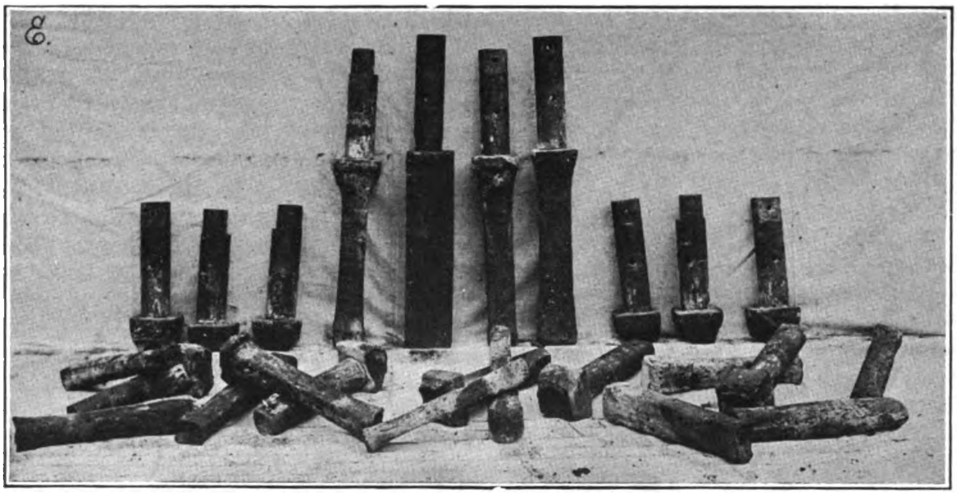


FIG. 3. ORDINARY ELECTRODES AFTER 12 MONTHS' SERVICE

nary labor. There are no moving parts and the entire structure is rugged and durable.

The Anode: The anode is made up of the most economical shape and size of graphite obtainable. Any change in the relative dimensions results in a higher price per lb. The machine work is extremely simple, permitting rapid production with minimum labor. The original appearance of the anode blocks can be seen in the illustration of the cell and in the center of the two illustrations showing anode blocks only. Illustration No. 3 shows a set of anode blocks with no special treatment which have been run 12 months without renewal of the diaphragm. Illustration No. 4 shows a set of specially treated anodes which have been in service six months before the diaphragm was changed and then for a year before the second diaphragm renewal. They are apparently good for another year at least.

Life of the Cell: The life of the tanks is not definitely known, as some over ten years old are still in service and it is estimated that they will last twenty years. The screens last two to five years except when an accidental local electrolytic action occasionally causes a local hole that would cost more to repair than the cost of a new screen. The asbestos diaphragms are put in new every six to eight months when the cells are washed out. The new process anodes give efficient service for two to three years. The life of the other miscellaneous parts is largely dependent upon the care with which they are handled and operated.

Floor Space: Allowing ample aisles, the production of chlorine per square foot of floor space per 24 hours is about 2½ lb. A high floor space factor means a saving in installation of piping, bus-bars, etc., per unit of output.

Attendance: With cells provided with the automatic feed controls, one attendant is ample for two hundred. At the plant of the Warner-Klipstein Chemical Co., South Charleston, W. Va., there is only one attendant for 480 cells.

Quality of the Chlorine Gas: As previously mentioned, this cell was specially developed to produce relatively pure chlorine gas for the manufacture of chemicals. How successfully this was accomplished may be judged from the fact that large groups of cells have been run for periods of several weeks with the gas analyzing 99.5 to 99.8 per cent Cl and have been operated continuously producing gas averaging 99 per cent pure. Only ordinary precautions are required to keep the gas substantially free from air, without permitting the escape of chlorine gas into the atmosphere of the cell room.

Quality of the Caustic: A considerable amount of undecomposed salt of course passes into the caustic liquor from all diaphragm cells, but this is readily removed in the evaporator. Far more serious is the presence of chlorates or hypochlorites. In spite of the high temperature at which these cells operate, chlorates are not found in the caustic and it is very rarely that hypochlorites can be detected. The surest hypochlorite indicator is the life of the tubes in the evaporator, even small amounts of hypochlorite greatly shortening the life of the tubes. In some caustic plants this is a serious problem, but with this cell a life of two years is not uncommon.

Efficiency: Theoretically 1000 amp. require 115 lb. of NaCl and should produce 69.86 lb. Cl and 78.67 lb. NaOH. Plant records actually show about 90 per cent ampere efficiency and 60 per cent energy efficiency.

The energy efficiency is the important figure. Several commercial cells operate, or claim to operate, at higher ampere efficiencies than the Nelson cell, but the gain is wholly illusory if the energy efficiency drops to 55 per cent at the same time. In one case the energy consumed is 1.53 kw.-hr. per 1 lb. of Cl, and in the other case 1.67 kw.-hr. are required, even though the ampere efficiency was 5 per cent better. This means a saving of nearly 5c. per cell per day, or about $4,000 per year in a plant producing 6 to 7 tons chlorine per day, assuming power to cost $0.005 per kilowatt-hour.

The operating data over a long period at one plant gave an average voltage drop of 3.7 volts per cell over a period of six months, varying from 3.5 to 3.8 volts. The high average energy efficiency is due to the fact

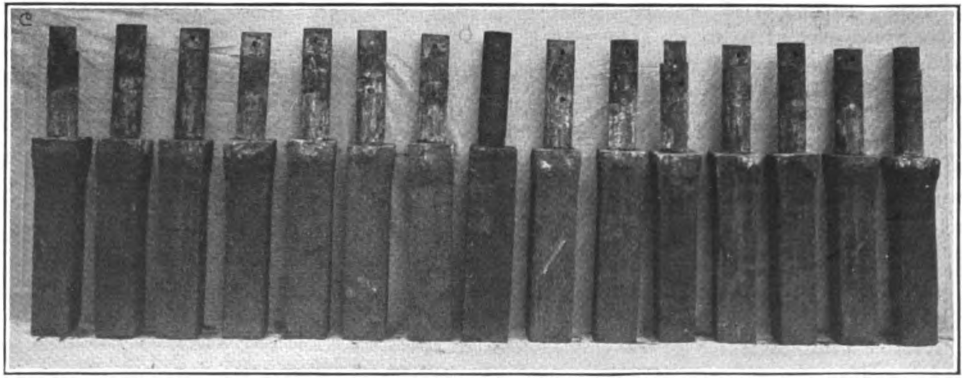


FIG. 4. TREATED ELECTRODES AFTER 18 MONTHS' SERVICE

that the cells start at a very low voltage which remains almost constant up to the end of the operating period.

Assuming that 2.3 is the correct factor for the theoretical decomposition voltage of NaCl in a water solution, the energy efficiency at 3.7 volts is 62 per cent and at 3.5 volts is over 65 per cent.

CONCLUSION

It is not claimed that absolute perfection has yet been obtained, but it is believed that this cell has reached a stage where experiment and abstract theory are things of the past. It is now a fully developed "machine" for manufacturing chlorine gas, that a chemical manufacturer can purchase as he would a filter press, a still, an evaporator or any other piece of standard chemical engineering equipment, and be assured of a fixed regular output of high quality, produced in a moderate costing, efficiently operating plant, which can be operated with ordinary labor with economical operating costs and repairs.

The author wishes to acknowledge the assistance of Mr. Nelson, who supplied some of the data and the illustrations for this paper, and also to thank the Warner Chemical Co. for the release of data and information.

Water-Resistant Glues

By F. L. Browne

UNTIL comparatively recently, practically all glues used in joining wood were the more or less impure forms of gelatin obtained by extraction from waste animal products such as hides, skins, bones, horns, hoofs, fish parts, etc. These glues are either of the solid or liquid type. For use the former are soaked in the proper amount of water, heated to a temperature slightly above their melting point, and applied to the surfaces to be joined, which are then put under pressure. On cooling and drying the glue film gives a strong joint. Liquid glues are applied cold and harden in the joint on drying.

Although gelatin glues of good quality yield very strong joints, they are subject to the disadvantage of softening to the extent of losing their holding power when kept in contact with much moisture, whether in the form of water or of high atmospheric humidity. Attempts have been made to increase the water resistance of gelatin glues by the addition of certain chemicals, but, although some progress has been made, satisfactory results have not yet been obtained. The only way so far found to make such joints serviceable under humid conditions is to keep the water away from them by using waterproof coatings.

The vegetable glues, made by heating starch (chiefly cassava starch) and water, in the presence of alkali lose their strength as gelatin glues do when exposed to humid conditions and can be made waterproof only by means of protective coatings.

Glued joints in an aëroplane are frequently subjected to very severe moisture conditions, and hence water-resistance is usually a large factor in the choice of an aëroplane glue. The known high strength and dependability of gelatin glues made it advisable to use them for propeller construction rather than glues whose characteristics were not so well known, especially since it was found possible to apply waterproof coatings. But for many plywood parts of aëroplanes, waterproof coating is not practicable, so that the use of water-resistant glue becomes a necessity.

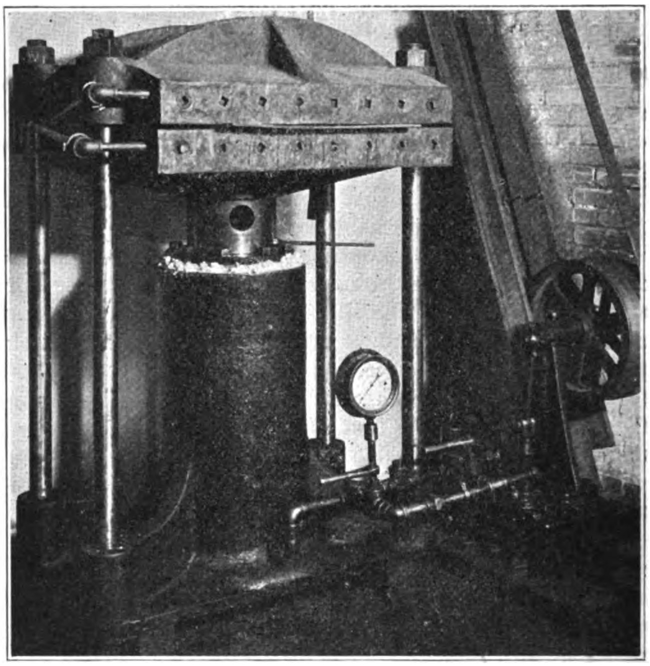
At present there are two types of these in use, one having casein as a base and the other blood albumin. These glues are water-resistant in the sense that the amount of water the dry glue films on the joints will take up is limited and the saturated glue still has sufficient strength to hold the joined surfaces together.

In order to control properly the quality of plywood glued with water-resistant glues and to develop glue production it was necessary for the Bureau of Aircraft Production to know how to make and use these glues. The Forest Products Laboratory of the U. S. Forest Service was therefore requested to investigate the subject. Research work was started late in 1917 and is still being continued. The following information is based on the results thus far obtained:

BLOOD ALBUMIN GLUE

Blood glues are a very recent development, in this country at least. The few plants using them before the war had their own secret formulas, and there has been very little information published on the subject.

Water-resistant glue can be made from fresh blood and where a supply is readily obtainable from a nearby slaughter house this may be the cheapest way to make it. The desirability and convenience of using the fresh blood, however, are open to question. Blood is subject to rapid bacterial decomposition, and hence where it cannot be utilized at once, it must be treated with a preservative or processed and the dried blood albumin used.



HOT PRESS FOR MAKING EXPERIMENTAL PANELS WITH BLOOD GLUE

The material ordinarily used for making blood glue is the black soluble albumin which remains after subjecting blood to a process for removing the fibrin and part of the hæmoglobin or red corpuscles, and carefully evaporating to dryness. This material is not only cheaper than the albumin from which all hæmoglobin has been removed, but has been found to give a stronger glue. It is stable over a reasonably long period of time, but the solubility gradually decreases with age. Since only the soluble portion of the albumin forms the essential glue-making material, freshly dried blood is more desirable. Loss of solubility likewise makes it impracticable to prepare blood albumin glue in the form of a dry powder ready for mixing with water.

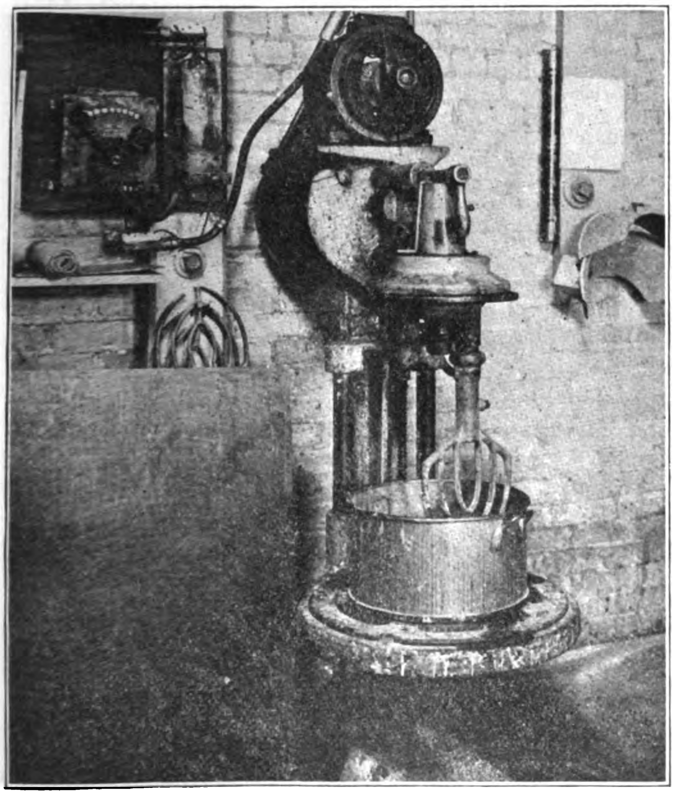
HARDENING BLOOD GLUE

Blood glue must be hardened by heating it to a temperature at which the albumin coagulates. This effect is ordinarily accomplished by the use of a hot press. The press commonly used is of the hydraulic type with hollow platens heated by steam. Blood glue is chiefly suited to plywood manufacture. Heavier joint work can be carried out, however, by clamping together the glued surfaces and subsequently placing them in a dry kiln or chamber at the proper temperature until the blood is coagulated.

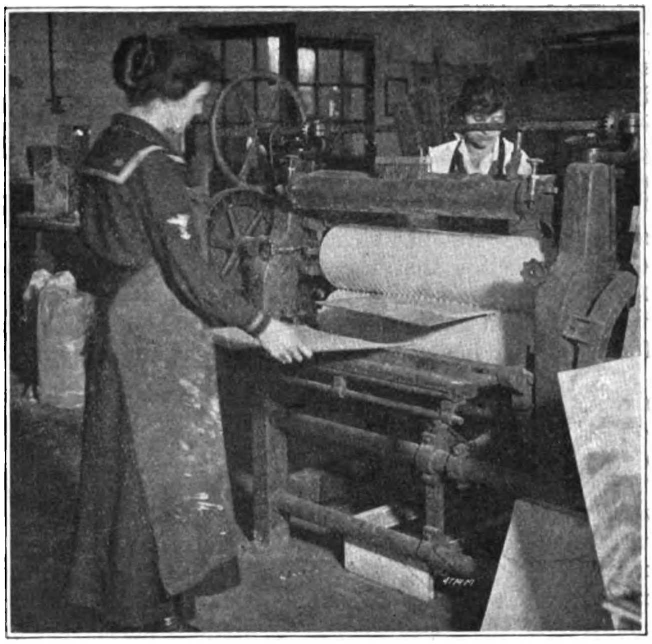
Albumin coagulates at temperatures above 162 deg. F., but a temperature of about 212 deg. F. is usually employed in the press. For glues containing much inert material, temperatures as high as 300 deg. F. are sometimes used, but blisters are likely to result. A satisfactory pressure is about 150 lb. per sq.in. The time required for pressing depends upon the thickness of the outer plies; the thicker the plies the longer it takes for the heat to penetrate the wood and coagulate the glue. For $\frac{3}{16}$-in. 3-ply material, 3½ to 4 min. at 212 deg. F. are sufficient. The action of blood glue in hardening is the same as that which takes place in the white of an egg on boiling.

WATERPROOF GLUE

A waterproof glue can be made simply by dissolving blood albumin in water. The glue is improved, however, by the addition of a little ammonia and lime, and may be cheapened without great loss in strength by the addition of other ingredients. Too much lime must not be used, since it causes the mixture to set quickly to an unworkable jelly.



MIXER FOR CASEIN GLUES



MECHANICAL GLUE SPREADER IN OPERATION

A very satisfactory blood glue[1] is made by soaking six parts of black blood albumin in eleven parts of water for at least 2 hr., then stirring and passing the mixture through a 30-mesh screen to remove undissolved particles. One-fourth part of ammonium hydroxide solution (specific gravity 0.90) and 0.18 part of hydrated lime are then stirred in. The lime is added in the form of a thick cream made by mixing the powder with a little water.

CASEIN GLUE

Casein glues seem to have been known for a much longer time than blood glues, especially in Europe, but have not found any great use, so far as is known, until the last few years. During the war they have been used in American, British, French, Italian and German aëroplanes. Much more information is available in the chemical literature and old patents on this subject than is the case with blood glue.

Casein is a by-product of the dairy industry, obtained either from buttermilk or skim milk. Most of it comes from skim milk. The casein is precipitated by adding rennet, or acids, such as sulphuric or hydrochloric, or by allowing the milk to sour naturally, forming lactic acid from the milk sugar. There are many slight variations in the technique of the processes, so that the product obtained on the market is not uniform, the chief variation being in the ash content and the acidity. This variation frequently makes necessary slight changes in proportions in using different shipments of casein in a given glue formula.

Casein is very closely related chemically to albumin. It does not show such definite coagulation on heating; as in the case of albumin, however, certain chemicals have the property of causing its solutions to harden, forming jellies. Some of the casein jellies after drying will absorb only a limited amount of water. Casein glue is mixed at ordinary temperatures and the joints are pressed without heat until the glue has hardened, then they are dried down to the moisture content desired in the finished product.

---

[1] Government patent in the name of S. B. Henning, Forest Products Laboratory, applied for.

Casein glues may be divided into two classes: (1) "Wet" glues, in which the various ingredients are kept separate until the glue batch is to be made up for immediate use; and (2) "dry" glues, in which all the ingredients except the water are mixed to form a dry powder which can be kept until ready to use and then merely mixed with water.

A very simple but effective wet glue can be made using simply lime and casein, but it is open to the serious objection that its working "life" is only from 15 to 45 minutes. At the end of this time it has hardened to an unworkable jelly. The following formula for a wet glue has given very excellent results:[2]

$$\left.\begin{array}{l}\left.\begin{array}{l}\left.\begin{array}{l}\text{100 parts casein}\\ \text{130—280 parts water}\end{array}\right\}\text{Soak 15 minutes}\\ \left.\begin{array}{l}\text{15—22 parts hydrated lime}\\ \text{90 parts water}\end{array}\right\}\text{mix}\end{array}\right\}\text{mix}\\ \text{70 parts sodium silicate (water glass)}\end{array}\right\}\text{mix}$$

The casein is soaked in the water until thoroughly wet, the lime water is stirred in, and the sodium silicate added last. Stirring is continued until a smooth mixture, free from lumps, is obtained. The amount of water in which the casein is soaked as well as the quantity of lime used depend upon the composition of the casein, particularly upon its ash content. The life of this glue is usually about 8 hours.

In mixing dry glues, the powder is stirred into the proper amount of water until a smooth liquid results. With all casein glues, it is important that the mixing be done thoroughly so that the casein will be completely dissolved and the glue free from lumps. For the purpose a power cake mixer has been found to give very satisfactory results.

COMPARISON OF BLOOD AND CASEIN GLUES

Blood glue has the disadvantage, as compared with casein glue, of requiring hot pressing, which limits the output of the press and makes it less easily used for such joint work as gluing propeller laminations. Blood glue is not readily obtainable as a dry glue, whereas casein is. Casein glue has been somewhat less expensive, but a considerable amount of cheap inert matter can be introduced in blood glue without serious loss of strength. In the matter of water-resistance, blood glue possesses a slight advantage. Although blood and casein glues are more expensive than vegetable glue, their water-resistance will give them a wide application in the future. They are both in the early stages of development still, and much improvement in both cheapness and water-resistance may be looked for.

Forest Products Laboratory,
Madison, Wisconsin.

Bibliography on Casein and Casein Glues

"The Physical Chemistry of the Proteins." (1918 ed.) T. B. Robertson.
"General Characteristics of Proteins." Schryver.
"Chemistry of the Proteids." Mann.
"Chemical Constitution of the Proteids." Plimmer.
"Casein and Its Primary Cleavage Products." Chittenden.
"Caseoses, Casein, Dyspeptone, Etc." Chittenden.
"Chemie der Eiweisskorper." Cohnheim.
"Dairy Chemistry." Richmond.
"Commercial Organic Analysis." Allen.
"Dictionary of Applied Chemistry." (Latest ed.) Thorpe.
"Physiological Chemistry." Hammarsten-Mandel.
"Physiological Chemistry." Hawk.
"Industrial Chemistry." Rogers & Aubert.[3]
"General and Industrial Chemistry." Molinari.
"Casein, Its Preparation and Technical Utilization."* Scherer.
"The Manufacture of Casein From Buttermilk or Skim Milk." Dahlberg, U. S. Dept. of Ag. Bul. No. 661.
"Agglutinants of All Kinds, for All Purposes." Standage.*
"The Colloid Chemistry of Casein."—Stocks, Report of Report of British Association for the Advancement of Science, 1917-1918, p. 88.
"Casein and Its Technical Applications."—Marotta, *Annali di Chimica Applicata*, v. 6, p. 165.
"Casein, Its Utilization in the Paper Industry." *World's Paper Trade Review*, v. 46, pp. 281, 657.
"Casein." Reuter, *Papier-Zeitung*, v. 32, pp. 3286, 3374.
"Casein and Its Applications." Richardson, *Journal*, Soc. Dyers and Colorists, v. 25, p. 48.
"The Technical Production and Utilization of Casein." Kühl, *Südd. Apoth. Ztg.*, v. 52, p. 390.
"New York Produce Review and American Creameries," v. 31 (1), p. 12.
"Technical Casein, Its Examination and Utilization." Höpfner & Burmeister, *Chem. Zeit.*, v. 36, p. 1053.
"The Nitrogen Factor for Casein." Vaubel, *Zeit. öffent. Chem.*, v. 15, p. 53.
"Investigations of Casein and Curd." *Milch. Zentr.*, v. 6, p. 386.
"The Composition of Acid Curd." *Zeit. Nahr. Genussm.*, v. 22, p. 170.

PATENT LITERATURE ON CASEIN GLUES

U. S. Patent 838,785 }
845,790 } Isaacs, 1906
848,746 }
183,024 Ross
21,744 Gardner, 1896
609,200 Hall, 1896 (Reissue 11, 811, 1900)

BIBLIOGRAPHY ON ANIMAL GLUES

"Agglutinants of All Kinds for All Purposes." Standage, 267 pages, published by D. Van Nostrand, New York, 1907, $3.50.
"Glue, Gelatine, Etc." Dawidowsky, 282 pages, published by Henry Carey Baird & Co., 810 Walnut Street, Philadelphia, Pa., 1905, $3.00.
"Glues and Gelatines." R. L. Fernbach, 200 pages, published by D. Van Nostrand, New York, 1907, $3.00.
"Glue and Glue Testing." Samuel Rideal, 140 pages, published by Scott, Greenwood & Son, London, 1901, $4.00.
"The Glue Book." J. A. Taggart, Toledo, Ohio, 85 pages, published by the Republican Publishing Co., Hamilton, Ohio, 1913, $1.00.
"Specifications and Tests of Glue." Linder and Frost, *Proceedings*, American Society for Testing Materials, 1914, Part 2, pages 509 to 519.
"A Study of Various Tests Upon Glue." A. H. Gill, *Journal Industrial and Engineering Chemistry*, 1915, pages 102 to 106.
"Glue for Use on Airplanes." P. A. Houseman, *Journal Industrial and Engineering Chemistry*, 1917, pages 359 and 360. Republished in *Aviation*, July 1, 1917, pages 494 and 495; and in *Aërial Age Weekly*, June 18, 1917, page 462.
"The Grading and Use of Glues and Gelatines." Jerome Alexander, *Journal*, Soc. Chem. Ind., Feb. 28, 1906.

Tennessee Copper Co. to Enter Fertilizer Field

At present all of the sulphuric acid produced by the Tennessee Copper Co., amounting to about 360,000 tons of 50-degree acid annually, is being delivered to the International Agricultural Chemical Co. at the old contract price of $4.81 a ton. At the expiration of that contract in December, 1920, the company will manufacture acid phosphate and, since the acid plant is the largest in the world[1], it will undoubtedly become one of the leaders in the fertilizer field. Phosphate rock will be obtained from the extensive deposits of the Stuart-Memminger interests in Polk County, Florida, which have been purchased recently by the Tennessee Copper & Chemical Corp. The tonnage of rock already proved in these properties will take care of the company's requirements for a long time to come.

---

[2] Government patent, U. S. No. 1,293,396, granted S. Butterman, Forest Products Laboratory, Jan. 14, 1919.

[3] Contains information on casein glue.

[1] For a description of the acid plant see CHEM. & MET. ENG., Vol. XIX, p. 404.

Carbide Conversion Calculations

By Ismond E. Knapp

In carrying on experimental work in connection with the manufacture of calcium carbide, considerable time was consumed in making the necessary calculations. Changes were being made in the design of the furnace, and it was important to know the efficiency of conversion that was obtained in each run. Inasmuch as the quality of the coke and lime varied considerably, this calculation was rather tedious. In order to simplify it, the following method was worked out, and it has proved entirely satisfactory.

The reaction may be represented by this equation:

$$\begin{array}{ccccccc} CaO & + & 3C & = & CaC_2 & + & CO \\ 56 & & 36 & & 64 & & 28 \end{array}$$

Analysis shows that the crude carbide or furnace product contains only a small amount of free carbon (seldom over 1.0 per cent) and but very little sulphur. These small amounts are neglected in these calculations, and it assumed also that all of the constituents in the coke ash and the impurities in the lime (such as SiO_2) go through the carbide furnace unchanged, and are present in the furnace product. On this basis the furnace product will have only the following constituents:

(1) Calcium carbide.
(2) Coke ash.
(3) Lime impurities.
(4) Unchanged lime.

Let A = decimal fraction fixed carbon in the coke.
B = decimal fraction ash in the coke.
C = decimal fraction CaO in the lime.
D = decimal fraction loss on ignition of the lime.

Then, $1 - A - B$ = moisture + volatile + sulphur in the coke and $1 - C - D$ = impurities in the lime.

It is evident from the above equation that the theoretically correct proportions for a mixture of lime and coke are:

$$\frac{36}{A} : \frac{56}{C}$$

In case the proportions actually used are not the theoretical, care must be taken that they are calculated to the above form, and that only the factor 36 is affected. For instance, if a small excess of carbon were used, this factor might become 37 or 38. It can be determined easily by solving this proportion:

$$\frac{\text{lb. lime used} \times C}{\text{lb. coke used} \times A} = \frac{56}{X}$$

whence, X = the factor to be used in place of 36 in all of the following formulæ.

Assuming that the efficiency of conversion, E, is known, then the weight of CaC_2 in the furnace product from a coke-lime mixture of the above composition will be $64E$. The weight of the coke ash will be $\frac{36}{A}B$; the weight of the impurities from the lime will be $\frac{56}{C}(1 - C - D)$; and the weight of the unchanged lime will be $(1 - E)56$. The corresponding amount of unchanged carbon, $(1 - E)36$, apparently is burned, and so does not appear in the furnace product. Now, if F represents the total weight of the furnace product, we may write:

$$F = \text{carbide} + \text{ash} + \text{dead lime} + \text{excess lime}$$
$$= 64E + \frac{36B}{A} + \frac{56(1 - C - D)}{C} + (1 - E)56 \qquad \text{(I)}$$

The purity of the furnace product, P, is of course the ratio of the weight of CaC_2 in the furnace product to the total weight of the furnace product, *i.e.*

$$P = \frac{64E}{F}$$

or, substituting the above expression for F,

$$P = \frac{64E}{64E + \frac{36B}{A} + \frac{56(1 - C - D)}{C} + (1 - E)56}$$

By rearranging this equation we finally obtain:

$$E = \frac{P\left(\frac{36B}{A} + \frac{56(1 - C - D)}{C} + 56\right)}{64 - 8P} \qquad \text{(II)}$$

A and B are known from the coke analysis; C and D are known from the lime analysis; and P is known from the analysis of the crude carbide. Hence the efficiency of conversion can be calculated quickly by simple substitution.

The following example will show the practical application of the foregoing formula:

Data:
Coke analysis: 0.903 fixed carbon, 0.069 ash.
Lime analysis: 0.768 CaO, 0.177 loss on ignition.
Mixture ratio: 200 lb. lime to 130 lb. coke.
Charged into furnace: 766 lb. of above mixture.
Recovery: 459 lb. crude carbide.
Analysis of product: 0.076 CaC_2.

Calculations:

$$\frac{200 \times .768}{130 \times .903} = \frac{56}{X}, \text{ whence } X = 36.3$$

Then the proportions in the mixture are $\frac{36.3}{A} : \frac{56}{C}$

$A = 0.903$; $B = 0.069$; $C = 0.768$; $D = 0.177$; $P = 0.760$.

Then by formula II, $E = 0.824$ or 82.4 per cent efficiency of conversion.

As a check on the above calculation it is often of interest to go back and calculate the weight of the furnace product, using formula I for F. The result thus obtained should show a fairly close agreement with the weight of furnace product actually obtained. The writer has checked repeatedly within 3 per cent in this manner.

For instance, in the example given above, the weight of the charge can be computed thus:

$$\frac{36.3}{A} + \frac{56}{C} = \frac{36.3}{0.903} + \frac{56}{0.768} = 113.1$$

By formula I, $F = 69.4$.

The weight of the charge actually used was 766 lb.

Hence, $113.1 : 69.4 :: 766 : X$.

Whence, X = 470 lb. theoretical weight of the furnace product. This result shows a variation from the weight of the crude carbide actually obtained (459 lb.) of 2.3 per cent.

Sometimes it is desirable to know the maximum purity of the crude carbide that can be obtained from given raw materials, with an efficiency of conversion of 100 per cent. This can be found by putting $E = 1$

in the above formula for P, which then reduces to

$$P_{max} = \frac{64 \times 1}{64 + \frac{36\,B}{A} + \frac{56\,(1 - C - D)}{C}}$$

In the example given above the maximum purity obtainable is 90.4 per cent.

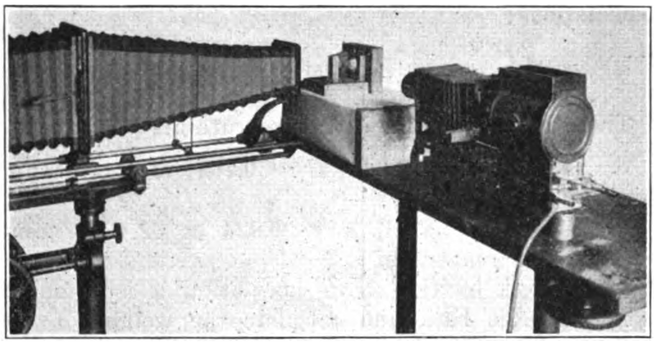
Although a high degree of accuracy is not claimed for these formulæ on account of the assumptions made regarding the chemical changes in the carbide reaction, nevertheless they have proved very helpful in the work for which they were developed.

Wilmington, Del.

The Photographing of Etched Sections of Steel Forgings at Low Magnifications*

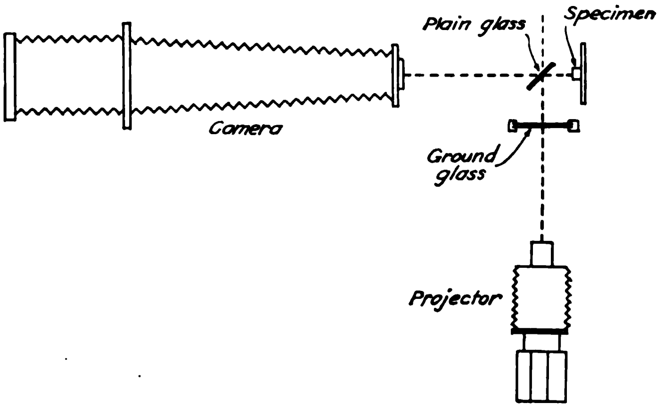
By **Francis B. Foley**
Metallurgist, Bureau of Mines

IT IS frequently found desirable to examine certain coarse-grained steel, for example steel in the forged condition, under low power for the purpose of getting a better comparison of grain size than is usually brought out in examining such steel by the microscope at magnifications of 50 diameters and higher. The desirability of low-power examinations of forgings became evident in recent investigations by the Bureau of Mines, where a grain size was found under the microscope which was difficult to record by photographing because the field covered by the microscope was too restricted, very often not sufficiently large to take in a single grain. An effort was therefore made to find a method of photographing a large area of the etched section without losing the relative value of the microconstituents. The apparatus that resulted was cheap and crude, but productive of excellent results, as may be observed in the accompanying illustrations, and, while the method adopted was not remarkable for its originality, it seems worthy of description and attention, since it appears that the photographing of etched specimens of steel at magnifications as low as 7 diameters by vertical illumination has not been practiced to any extent, at least not to the writer's knowledge.



INSTRUMENTAL SETUP FOR PHOTOGRAPHING CROSS-SECTION OF TEST PIECE

The apparatus with a specimen in place for photographing is shown in the half-tone illustration in this column. The illuminator should be of optically flat glass or glass in which there are no undulations which will interfere with the proper refraction of the light rays or with the focusing of the image. The illuminator used in taking the photographs shown in Figs. 1, 2, 3, 4, 5 and 6 was a small lantern slide from which the emulsion had been removed. A fairly bright, well diffused light is desirable and, in this connection, a ground glass diffusing screen is of considerable help. The light in the stereopticon lantern shown in the illustration is a 110-v. 400-w. lamp. The exposures, without a ground glass screen, were of 30 to 45 seconds duration.



PLAN OF APPARATUS

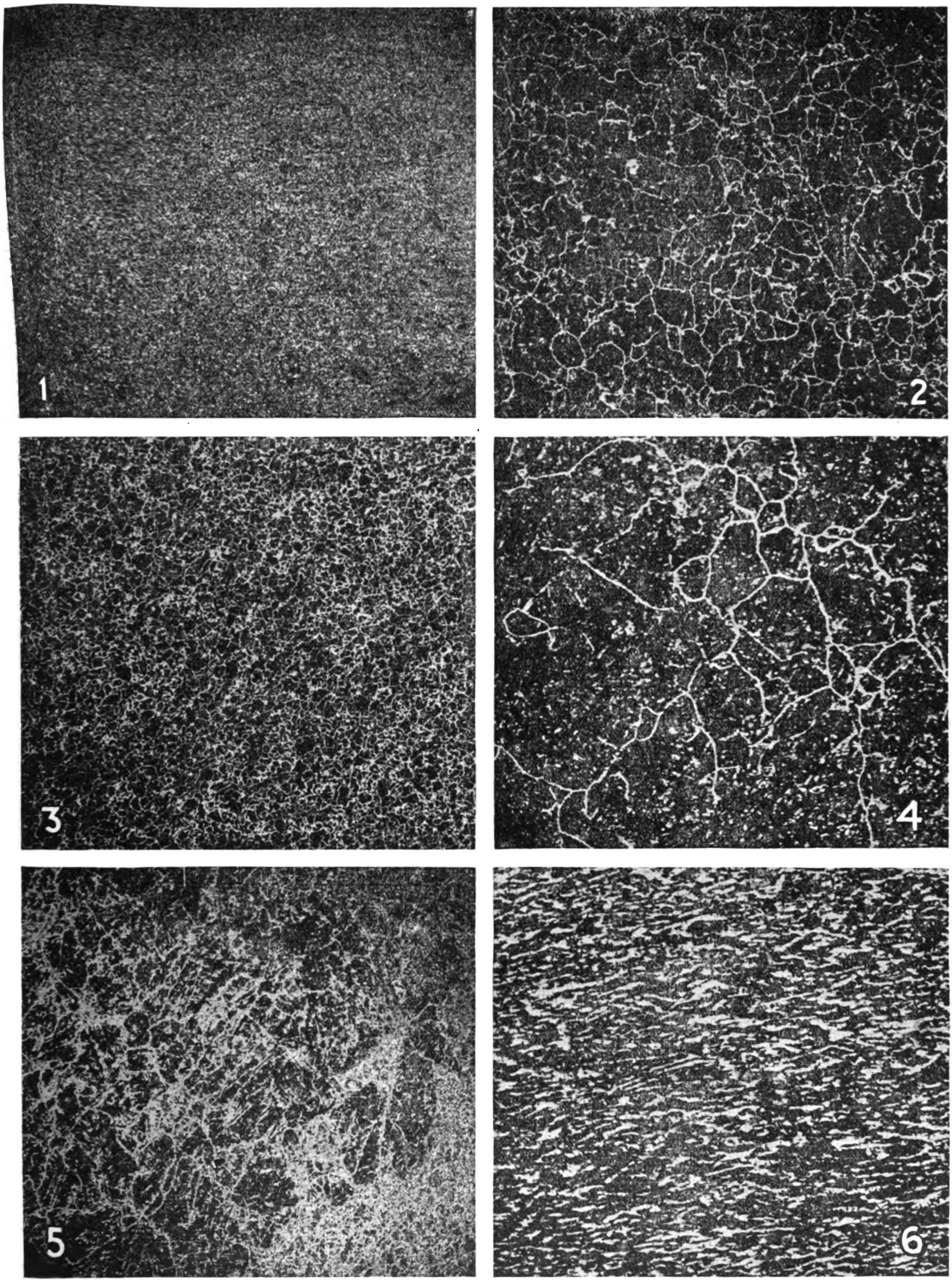
The remarkable variation which can be brought about in the condition of forged steel by improper or lack of temperature control stands out prominently when the large field which it is possible to cover at low magnification is offered for study. Fig. 1 represents the structure of a bar taken from an untreated forging, which, without heat treatment, gave an elongation of 18 per cent, and Fig. 2 the structure of a bar from the other end of the same forging, which gave an elongation of but 5 per cent. Were the entire forging in the condition represented by Fig. 1 a very simple heat treatment would suffice to put it in the best condition, but the condition shown in Fig. 2 makes it necessary to go to much greater trouble and expense to bring about a desirable structure. The platy arrangement of the ferrite in Fig. 6 is brought out to a better advantage in the 7-diameter magnification shown here than it could be in a small area at high power. The composition of the steel shown in this photograph was unusual only in sulphur, which was 0.05 per cent, whereas the usual product ran sulphur below 0.03 per cent. Figs. 1, 2, 3, 4, 5 and 6 do not represent specially selected forgings or structures which have been produced in a predetermined manner, but random selections from forgings put through the usual course of manufacture at the plant where the forgings were made. All are of 3 per cent nickel gun steel of 0.35 to 0.40 per cent carbon and have had no heat treatment subsequent to the forging operation and serve well to show the wide variation in structure which heat treatment is called upon to correct.

Etching for photographing in the manner described here has been done with the usual picric acid reagent, but the etching has been carried deeper than is usually done for ordinary microscopic examination. The pearlite areas are etched quite dark, but if the specimen is thoroughly washed in water after etching, preferably under a running stream, and then dried, the structure developed is very good for examination at high power in spite of the very deep etch.

Pittsburgh, Pa.

---

*Published by permission of the Director of the U. S. Bureau of Mines.



FIGS 1 TO 6.
Types of structure found in 0.35 to 0.40% C, 3% Ni steel gun forgings before heat-treatment. Figs. 1 and 2 represent opposite ends of the same forgings. Picric acid etching. Magnification 7 diameters.

Exposure Tests of Sheeting Material

Description of the Standard Sheeting Tested and Method Followed—Results Graphically Charted—Conclusion: The Best Sheeting Material Is a Copper Bearing Steel With 0.20 to 0.25 Per Cent Copper

By SAMUEL L. HOYT, E.M., Ph.D.
Associate Professor of Metallography, University of Minnesota, Minneapolis, Minn.

FOR the past three years the writer has been conducting exposure tests of sheeting material with the object of ascertaining the relative behavior of various standard commercial products such as the bessemer and open-hearth sheets, pure open-hearth iron sheets, and copper-bearing steel sheets. The sheets used were obtained from various manufacturers in this country and were supposed to represent typical commercial grades of these materials. As far as is known, there is no reason to believe that they were other than as represented.

The test specimens were exposed continuously to the rain, snow and sunshine, in amounts which are shown by the curves in Fig. 1, which were plotted according to the data kindly furnished by Mr. U. G. Purssell of the United States Weather Bureau, Minneapolis Station.

The test specimens, taken from each sheet submitted, were placed in a rack on the roof of the School of Mines building on the campus of the University of Minnesota. The air is comparatively pure, the only contamination being from a railroad passing through the campus on which the service is infrequent, and from two power plants situated on the campus some distance away from the place of the tests.

MATERIAL USED

Requests were made of leading producers to submit sheets of their standard sheeting one yard square and in the condition in which they left the mill. These sheets came in both 20-gage and 26-gage. The compositions of these materials are given in Table I.

TABLE I. CHEMICAL ANALYSIS OF SHEETS

Mark	Gage	Material	C	Mn	S	P	Si	Cu
25	20	Pure iron............	0.05	0.05	0.032	0.007	0.003	0.032
26	26	Pure iron............	0.05	0.05	0.025	0.006	0.003	0.032
29a	20	Copper-bearing.......	0.12	0.49	0.034	0.065	0.028	0.224
29b	20	Copper-bearing.......	0.11	0.47	0.031	0.057	0.019	0.220
31	26	Copper-bearing.......	0.13	0.47	0.031	0.058	0.026	0.224
31a	26	Copper-bearing.......	0.13	0.47	0.034	0.057	0.026	0.220
33	20	Bessemer............	0.09	0.45	0.041	0.092	0.003	0.008
33a	20	Bessemer............	0.09	0.45	0.049	0.095	0.005	0.008
35	26	Bessemer............	0.08	0.35	0.072	0.087	0.014	0.008
35a	26	Bessemer............	0.08	0.35	0.072	0.087	0.014	0.008
37	20	Pure iron............	0.038	0.034	0.030	0.007	0.005	0.040
38	26	Pure iron............			Same as 37			
41	20	Copper-bearing.......	0.10	0.48	0.040	0.009	0.003	0.260
42	26	Copper-bearing.......	0.06	0.47	0.041	0.010	0.003	0.272
43	20	Pure iron............	0.05	0.05	0.019	0.004	0.003	0.024
44	26	Pure iron............	0.05	0.04	0.020	0.002	0.009	0.036
45	20	Open hearth..........	0.10	0.43	0.030	0.011	0.136	0.064
46	26	Open hearth..........	0.12	0.35	0.039	0.018	0.117	0.028

CONDUCT OF THE TESTS

From each sheet submitted were cut a number of small specimens 1½ x 3½ in., and marked for identification according to Table I. These specimens in their natural condition were then weighed and placed in a rack on the roof of the School of Mines building. The specimens were arranged in rows numbered from I to X inclusive, each row containing one sample from each sheet submitted. At the end of the first period only the specimens in the first row were taken down and the remaining specimens were not touched. After cleaning off the rust and weighing, the I specimens were replaced in their proper position in the rack. At the end of the second period the first two rows, or the I's and II's, were taken down and cleaned and weighed and then returned to the rack. This procedure was continued so that at the end of each period another additional row of specimens was taken down along with all those which had previously been taken down and cleaned and weighed and, in turn, all returned to their places in the rack. At the end of the tenth period the number X's were taken down for the first time, so that they had been exposed continuously, that is, without intermediate cleanings, for the entire period of three years. In this way the effect of leaving the rust coating on as well as of removing it could be ascertained.

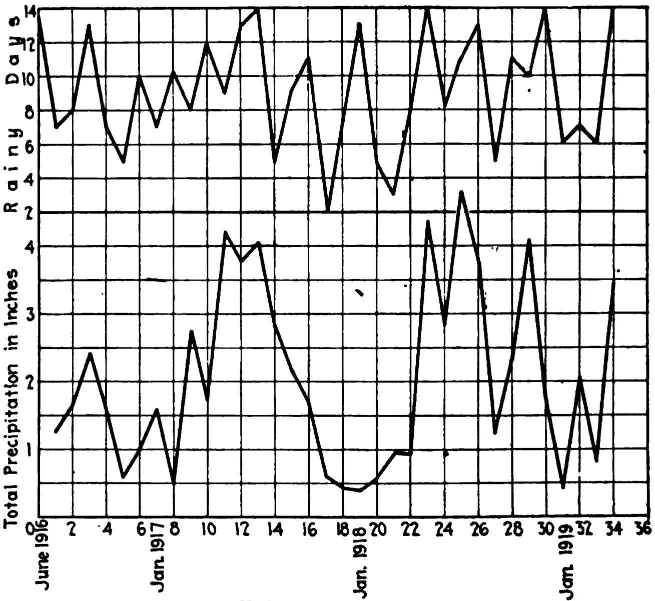


FIG. 1. WEATHER CONDITIONS DURING TEST

RATE OF CORROSION

The rate of corrosion was determined by noting the difference in weight before exposure and after removing the rust film. The loss in weight represented that portion of the specimen which had rusted or corroded over the corresponding time interval. The method used to remove the rust was that of treating in hot ammonium citrate, which as far as could be observed gave entirely satisfactory and comparable results. Other corroborative evidence of the rate of corrosion was obtained from the total failure of the specimens and their general appearance.

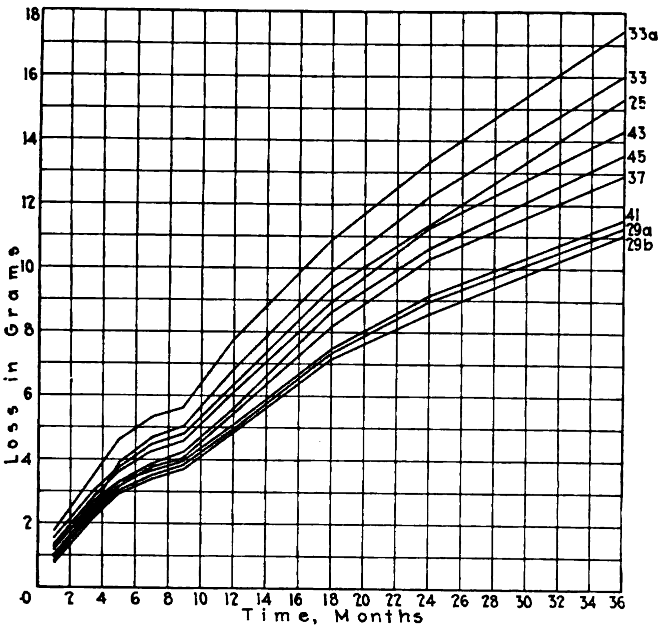


FIG. 2. WEIGHT LOSS; 20-GAGE, NO. I SAMPLES

The idea underlying this test was to secure a reliable index to the rate of corrosion, and by treating all the specimens exactly alike to determine the relative corrosion of the various materials submitted for the tests. The agreement between "loss in weight" determinations and the absolute failure of certain materials on the one hand, and the tenacious resistance to corrosion of other materials on the other hand, has given the writer complete confidence in the index of corrosion furnished by the data which are presented here.

PRESENTATION OF RESULTS

First of all it should be stated that no conflicting or contradictory data have been secured, to the writer's knowledge, to cast doubt upon the general validity of the results; consequently it is held that it is not necessary at this place to reproduce all the data obtained or all the curves which have been plotted, and hence only certain selected data are here reproduced in Figs. 2 to 7.

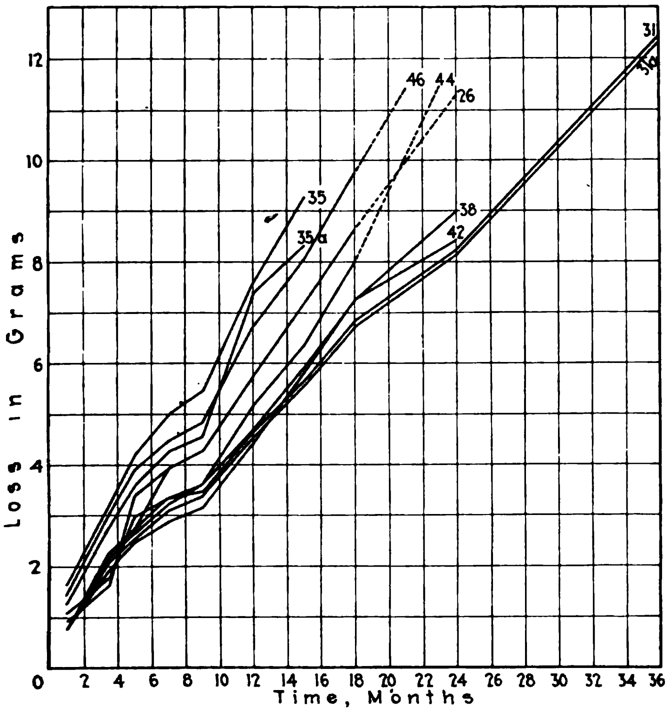


FIG. 3. WEIGHT LOSS; 26-GAGE, NO. I SAMPLES

Fig. 2 represents the loss in weight in grams of the 20-gage, No. I specimens. It will be remembered that these specimens were cleaned at the end of each exposure period, these periods being at the end of 1, 3½, 5, 7, 9, 12, 15, 18, 24 and 36 months respectively. The order of excellence of the materials represented by this test is 29b, 29a, 41, 37, 45, 43, 25, 33 and 33a. It will be noted that the 20-gage specimens were still intact at the end of three years' exposure.

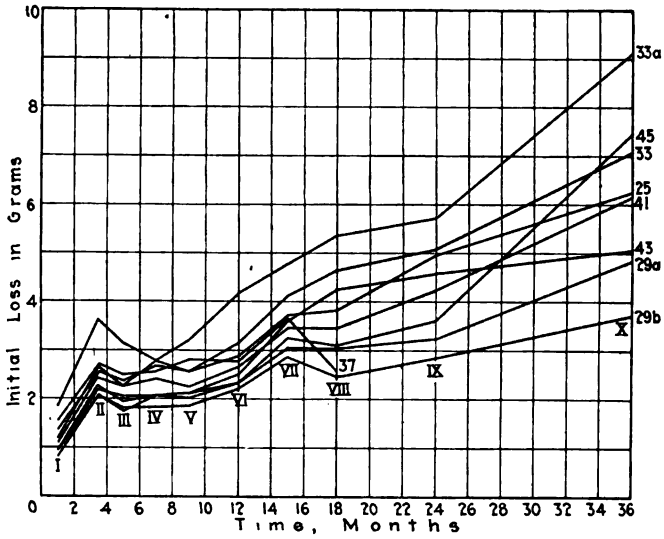


FIG. 4. RATE OF CORROSION UNDER CONTINUOUS EXPOSURE; 20-GAGE

Fig. 3 represents the same tests on the 26-gage specimens. The 35's failed completely at the end of 15 months. The 26, 44 and 46 failed between 18 and 24 months, and the 38 and 42 failed completely at the end of 24 months, while the only specimens which were still intact at the end of 36 months were the 31's. These specimens were just about as good as gone, so that the loss in weight is taken as the total or original weight. The order of excellence is 31a, 31, 42, 38, 26, 44, 46, 35, 35a.

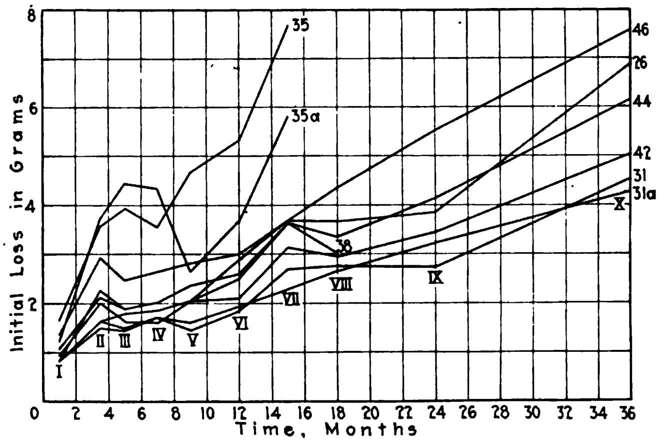


FIG. 5. RATE OF CORROSION UNDER CONTINUOUS EXPOSURE; 26-GAGE

Fig. 4 is intended to show the rate of corrosion under continuous exposure, that is, without removing the rust film at the end of each period. It was necessary to take a new specimen for each period represented so that the I specimen was taken at the end of the first period, and II at the end of the second period, the III at the end of the third period, and so on up to the X specimen at the end of the three years. It is hardly to be expected that these curves will show as uniform results as the I's or the II's or the III's, etc., plotted separately. The rate of corrosion in this case is appreciably less because the protective coating of rust is allowed to remain on the specimens for the full time for each period. The order of excellence of the 20-gage specimens in this series taken at the end of 36 months is 29b, 29a, 43, 41, 25, 33, 45, 33a.

Fig. 5 corresponds to Fig. 4 except that it represents the 26-gage sheets. Here again it will be noticed that certain of the specimens failed prior to 36 months. Samples 35 and 35a failed at the end of 15 months. The order of excellence of the specimens in this test is 31a, 31, 42, 44, 26, 46, 35a, 35.

In order to compare the relative resistance to corrosion of copper-bearing steel, pure open-hearth iron and plain steel, the various specimens were divided into these three classes and the average loss in the weight for each class calculated. The results obtained for the number I specimens are shown in Fig. 6, in which both gages are represented. The order of excellence, which remained the same for the entire period, is copper-bearing steel, pure iron, and plain steel.

Fig. 7 represents the average losses of these three types of materials at the end of each period in case the protective coating was allowed to remain on for the total time up to the end of the period. Here again slight irregularities may be noticed, but the same order of excellence is obtained, and this remains the same throughout the entire 36-month period. It is as before, copper-bearing steel, pure iron, and plain steel.

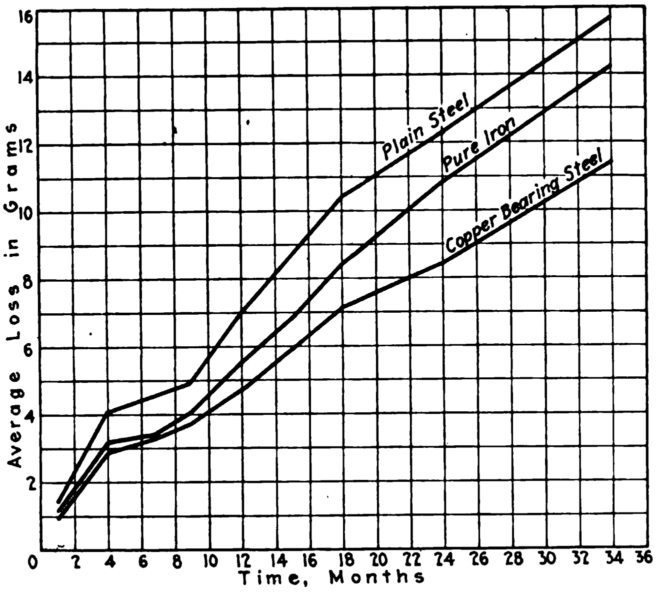


FIG. 6. RELATIVE RESISTANCE TO CORROSION; RUST REMOVED PERIODICALLY

CONCLUSIONS

The general conclusion which, it is believed, may be drawn from this exposure test is that the so-called copper-bearing steel, in which the copper content is about 0.20 to 0.25 per cent, offers the greatest resistance to corrosion of the common sheeting materials. After copper-bearing steel come pure open-hearth iron, open-hearth steel and bessemer steel in the order of excellence. As evidence of this fact we have the loss in weight, the ultimate failure of the materials and their general appearance both before and after removing the rust-coating. It was noted that while the copper-bearing steel, as compared to the other materials, has a particularly dense protective coating of rust, the material itself has an abnormally low tendency to oxidize in moist air. On this account it is not sufficient to explain its resistance to atmospheric corrosion as being due primarily to the nature of the rust-coating. A more plausible explanation seems to be that the copper, by entering into solid solution in the iron, lowers the solution pressure of the iron. The physical character of the rust-coating may be merely a manifestation of the rate at which the coating is formed.

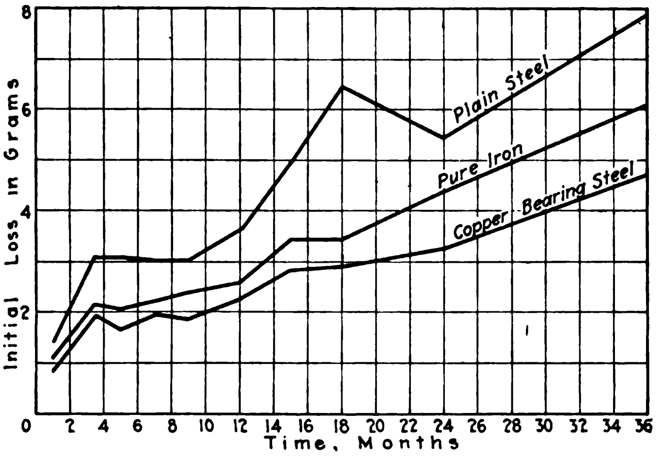


FIG. 7. RELATIVE RESISTANCE TO CORROSION; CONTINUOUS EXPOSURE

The two best sheeting materials, according to this test, are copper-bearing steel and pure iron. Aside from the superiority of the former, it may be of interest to note that, from the metallurgical point of view, it is both cheaper and more economical of time and materials to produce copper-bearing steel, as compared to pure iron. Thus heats of copper-bearing steel can be made according to standard practice and in standard time with a final addition of about a dollar's worth of copper per ton of steel. Pure iron, on the other hand, is a difficult product to make on a large commercial scale and requires high temperatures and something like 20 to 24 hr. per heat. Both as regards resistance to atmospheric corrosion and cost of production, copper-bearing steel seems to possess a decided advantage over pure open-hearth iron as a sheeting material.

Japanese Developing Steel Industry

The American Chamber of Commerce in London understands that a British naval correspondent in Japan foresees the end of Japan's dependence on steel imported from the United States and Great Britain. The Japanese are said to be exploiting on a large scale the ores which they have discovered in Korea and to be making extensions of their industries to handle this new source of supply. Ore concessions in China will further increase the Japanese raw material. This British correspondent predicts not only that Japan will soon be independent of outside sources of supply but that in another 10 years' time she will be exporting cheap steel to the Pacific markets.

Flakes in Alloy Steel

A Recapitulation and Discussion of Recently Published Matter About This Baffling Defect Appearing in Gun Tubes and Other Large Forgings of Alloy Steels — There Are Probably Two Kinds of Real Flakes, but Only One Kind Which Is Dangerous

By ERNEST EDGAR THUM

TWO years ago an enormous expansion in our ordnance program caused many concerns to produce large alloy-steel ingots and forgings—a class of output entirely new to them. As an instance, high-strength gun tubes were needed in great numbers, to the most exacting specifications, requiring test bars cut at right angles to the axis. Immediately there appeared bright silvery areas in otherwise normal test bar fractures, associated with low and variable elongation and contraction in area, causing rejection of a tremendous tonnage even though the elastic limit was unaffected and the ultimate strength lowered but slightly. Failure of more than half the production to pass acceptance tests caused earnest inquiry on many sides, despite the fact that many production-mad concerns profited as much from bad forgings as from good.

Coarse crystalline areas in fine crystalline breaks have been noted before—indeed, can be produced at will by straining a portion of sound metal to a critical point, followed by continued annealing below recalescence. But the defects in question appear to have little depth; the so-called flake often exhibited warped surfaces such as the rounded corners and ends of squeezed macro-crystals. Numerous names were given them, they seemed to occur at different stages in the history of the piece, from a wide variety of causes, and the whole situation was fraught with the most extreme confusion. Most investigators now agree, however, that a flake results from a series of intercrystalline cracks, produced by stresses set up in the metal by its treatment, the location being determined by points of weakness already existing; in other words, a flaky steel contains a series of internal "bursts" in heterogeneous metal. Homogeneity is the obvious remedy; given sound ingots and barring amateurish forging and heat treatment or rough handling, a piece free of this defect should result. Actually this was the case; fewer and fewer rejections came with continued experience.

EXISTENCE OF TWO KINDS OF FLAKES

If, then, a flake is an intercrystalline crack, does it exist as a crack in the metal during and after its fabrication, or is it a plane of weakness which spreads from a minute parting only on stress? Probably both. The evidence suggests that there are two kinds of flakes; the one due to actual cracks in clean metal and the other to inclusion films. Large cracks pre-existing in a test piece will evidence themselves by correspondingly low values for elastic limit and ultimate; eliminating from this discussion, however, the unwelded tears due to unreasonable reduction and rough handling, a true flake is something which does not lower the elastic limit of the test piece materially. But take a good ingot, saw through it parallel to the base and polish this new section. Without any etching will appear short hair-lines in the polished surface, doubtless traces of actual partings.

Such tiny cracks have a habit somewhat depending upon the shape of the ingot; probably they are due to stresses thrown into the shrinking metal as it cools through the tender heat just below recalescence; the exact nature of these stresses is somewhat obscure, however, and a variety of opinion exists. However, in a given heat, such flakes will appear independently of the size, shape and method of pouring; being deep seated, they may be welded shut if high-temperature forging is sufficiently penetrating and the burst contains no oxidized inclusions. Clean small cracks in the ingot should thus constitute no insurmountable defect in the metal. Ultimately they may be due to a certain homogeneity in the metal, and are thus closely related to flakes due to inclusion films, although in the former case the heterogeneity may be a normal incident of perfectly well-made metal.

Rawden, however, finds a very thin film of slag at the ends of flakes in forged tubes. This inclusion evidently permits the original separation and later prevents proper welding, as well as forming an internal notch inducing premature failure under stress. Other observers also note evidence of slag in flaky fractures, and describe flakes as a recrudescence of local crystalline fractures due to the presence of slag—known for some time. Metal in contact with such slag inclusions generally shows a structural change—usually a decarburization—and such spots may well provide the nuclei from which fracture starts. On the other hand much "dirty" steel containing large quantities of solid nonmetallic impurities is not flaky, while many observers are positive that slag particles of microscopic size are not universally present in flakes.

WHAT CAUSES FLAKES

While it is a favorite method to ascribe visible effects to invisible causes, there is much to fortify the belief that flaky test bars are ultimately due to inclusions of oxidized material at the original grain boundaries, sometimes indistinguishable from tenuity, dispersity or lack of optical differentiation, but nevertheless persisting since the metal left the furnace or introduced by subsequent overheating. As such they prevent normal adhesion at the original grain boundaries, and while no extensive burst or crack may exist in the finished piece at such areas, as soon as the surrounding metal is stressed beyond its elastic limit, these brittle planes of weakness give way first, the fracture typical of a "flake" simulating the original but now deformed coarse-crystalline boundaries. Localized stresses then extend the fracture to failure with little contraction in area, typical of "notched" bars.

On this basis, flakes are caused by faulty furnace practice. They tend to run by heats, yet their occurrence is so variable that they are not due to any particular metallurgical practice or to any chemical composition—they are found in converter, basic and acid open-hearth and electric steels, and while giving most trouble in tender alloy steels (possibly due to their viscosity or crystalline habit) they have been found in common carbon steels when pulled transversely to the direction of working. Yet the flakiest steels have been produced on this side from the use of rusty turnings, light scrap, or excessive ore, or from stopping the boil, or casting insufficiently worked metal, and the defect has been largely eliminated by approximating the successful European practice of using only the purest materials, melted under a reducing flame, and worked with a minimum of iron ore. Whether like practice will eliminate the dangerous "gashes" and "fissures" in rail steel depends upon the moot question as to whether these defects are due to flakes in metal or to tearing the structure of excessive reduction in rolling.

Thus the higher oxides of iron trapped within the steel even in minutest particles seem to be the real culprits responsible for flakes; large quantities of a neutral slag will not cause like bad effects. As Giolitti points out, a tiny bit of oxidized material will so disturb the equilibrium existing in normal steel among ferrite, cementite and two carbonoxides that an excess of CO_2 will be formed, causing a local decarbonization and a thin border of ferrite on the surface of the original dendrites. This white ferrite—probably embrittled by other segregated impurities—is the plane of parting, and upon stressing produces the silvery, coarse-crystalline "flake." On such a basis it is evident that overheating before forging will cause flakes simply by the formation of "burned" spots where oxygen has penetrated into the liquid grain boundaries of otherwise sound metal. Again, flakes have formed on deep-seated carburization of what seemed to be perfect ball-races. Here an oxidized impurity caused a sharp variation in carbon concentration, and on hardening induced internal bursts by a mechanism exactly similar to that of exfoliation.

HOW TO ELIMINATE THE DEFECT

There yet remains to be explained, however, why there is no particular microscopic appearance associated with flakes other than a markedly non-homogeneous structure such as elongated dendrites, banded regions of excess ferrite or small grains. In other words, flakes often show no ferrite borders under the microscope, and grain refinement may exist up to the parting itself. But it should be remembered that the amount of excess ferrite induced by a tiny, almost invisible, inclusion is likely to be little more than the thinnest shell, which under proper heat treatment will quickly diffuse back into the sound metal. Heat treatment must be long continued, however, to allow slow-diffusing impurities to migrate away from their location, and to exhaust permanently the decarbonizing potentialities of a bit of oxide. Nor can it obliterate an internal crack any more than it can refine the grain of an exposed break—grain refinement occurs only up to the parting plane. In such cases the apparent crystallinity of a flake in hardened steel is a surface configuration only, but in fact persisting since the original crystallization of the ingot.

If the above analysis of the situation is correct, it is evident that the best way to eliminate flakes due either to cracks in ingots or to included films is by careful metallurgical practice, starting with the selection of proper charge components, continuing through melting, refining and casting stages into the mechanical reduction processes and heat treatment even up to the final anneal to release hardening strains, for flakes have appeared in all these stages.

It is idle to say that Americans cannot follow European methods and use purest raw materials, or that the way to eliminate flakes in nickel steel is to leave out the nickel. Sound alloy steel of high strength can be made if every energy be turned toward quality rather than quantity—a practice Americans like to talk about but seldom think expedient to put into practice. Should flakes appear in the ingot, it is doubtless best to scrap the ingot before spending a great deal of labor to make it into a forging, then only to be rejected.

Flaking in small degree may be cured, not by cutting more and more test bars until a good one is found, but by heavy reduction to knead the original structure and long annealing to allow the complete diffusion of soluble segregates. Mechanical reduction processes at correct welding temperatures and by moderate stages are obviously the most important factor in closing permanently clean and open cracks; a practice which only makes good metal better. Flakes from segregates can best be warded off by eliminating segregating impurities; long carefully planned heat treatment is required for the correction of this defect appearing in minute amount. Therefore dirty metal should be scrapped.

Such observations appear to be truisms, and so well accepted by the metallurgical fraternity as not to warrant repetition, were it not for the fact that the occurrence of flakes at a time of national danger is only another illustration of what happens when careful metallurgical practice is disregarded. One cannot make good cannon out of bad ingots, but can easily make bad cannon out of good ingots.

Attorney General Interprets War Minerals Relief Act

At the request of the War Minerals Relief Commission the Attorney General has rendered an opinion interpreting Section 5 of the Relief Act which was designed to reimburse net losses sustained by persons who were "producing or preparing to produce either manganese, chrome, pyrites or tungsten in compliance with the request or demand of the Department of the Interior, the War Industries Board, the War Trade Board, the Shipping Board or the Emergency Fleet Corporation." In his opinion the Attorney General stated that "one of the five Governmental agencies must have asked (either by request or demand) the claimant to produce or to prepare to produce one of the four named minerals. The statute specifies the five agencies authorized to make request or demand for the production of minerals, specifies the minerals, and specifies that the production, or preparation for production, must have been '*in compliance with* the request or demand' of one of the five agencies."

Under this interpretation it appears that those who sustained loss by producing or preparing to produce the minerals named in response to a general appeal or solicitation will not be entitled to relief under the provisions of the act.

Manufacturing Plant of the Providence Gas Co.—III*

Description of the Installation and Operation of a Battery of 40 Koppers Cross Regenerative, Combination, By-Products Ovens—Extension of the Coal and Coke Handling Apparatus—Treating of Coke Oven Gas

BY WALTER M. RUSSELL

AS EARLY as 1914 the engineers of the Providence Gas Co. felt that the Dessau vertical coal gas plant should never be extended in case additional coal gas equipment was needed; in fact, it was even recommended that that plant be abandoned and a new plant of Woodall Duckham vertical retorts be built in its place. After having had an opportunity to study the Dessau vertical plant for several years, it appeared that American conditions were so very different from European conditions that a type of plant which had proved successful abroad might not be so in this country. In 1914 the vertical retort had not been developed in this country to the extent that it now has, particularly in the use of silica material and labor saving devices. Therefore, the abandonment of the vertical retort plant at Providence must not be taken as a condemnation of the system or even of this particular plant. In April, 1917, a report was made, recommending that a coal gas plant of 6,000,000 cu.ft. daily capacity be built. Careful study was made of the existing types of plants in the United States. At about this time, Mr. John R. Freeman was elected president of the gas company, and during the year 1917 also was appointed as the company's engineer. By the time Mr. Freeman had become president of the company, the growth of the business was such that any system other than bulk carbonization appeared unsuited for this plant, which eliminated from consideration even the highly successful vertical retort plants typified by the works in Rochester, N. Y. In November, 1917, after an exhaustive study of the whole situation, Mr. Freeman brought in a report, recommending the construction of a Koppers combination gas oven plant with a nominal capacity of 700 tons of coal a day, and this plan was adopted.

COMBINATION GAS AND COKE OVEN DECIDED ON

Installations of Koppers ovens at St. Louis, Mo., and the Seaboard By-Product Coke Co., Jersey City, N. J., had been serving their respective cities with a part of the gas from the carbonized coal and had demonstrated the feasibility and value of such an operation. It was considered impossible, in the case of Providence, to operate a straight coke oven plant successfully, as the volume of coke for sale per thousand cu.ft. of gas sold appeared to be excessive. In the other installation of Koppers ovens, where the gas was used for city purposes, it was the rich portion of the gas which was so distributed, the lean portion being used to heat the ovens. The first intention was to build ovens at Providence which could be operated only as producer gas fired ovens, but later this plan was changed and it was decided to build a combination gas and coke oven which could be operated either as a gas oven or coke oven. A single collecting main only was supplied. Therefore, all of the coal gas, both the rich and the lean, is mixed at the collecting main and delivered through the plant to the storage holder. Gas can be taken from the storage holder and returned to the battery, being burned in the flues by means of the ordinary gas burners supplied with standard Koppers combination ovens. Also the ovens can be operated on producer gas. One of the reasons why this decision was arrived at was that it was intended to build a by-product producer gas plant and there were certain possibilities connected with starting up such an installation which made it advisable to have the alternative feature as a matter of safety and insurance for continuity of operation.

Also should the market for coke ever become capable of absorbing at a sufficiently high figure the entire output of the battery operating on its own gas, the water gas plant could make up the deficiency of coal gas output thereby occasioned.

DESIGN ALMOST ENTIRELY NEW

As there were no Koppers ovens operating in the United States on producer gas, it was necessary for the Koppers company to make a comparatively complete new design, particularly with reference to that part of the oven below the sole flue, including the regenerators, producer gas and fuel gas mains and passages and the apparatus for their control. Thus, this battery of ovens as it stands to-day represents something entirely distinct from any other plant yet built in the United States, but it has already demonstrated its value and justified the faith of the builders, and it will undoubtedly prove the forerunner of a series of such installations.

It was at first intended to erect a battery of producers to operate on coke breeze and small coke. These producers would probably have been of the well known Kerpely type, which has proved so successful in foreign Koppers oven installations. The writer first became associated with this project in the latter part of 1917 and brought to the attention of the company's engineers the great possibilities of the bituminous coal producer, particularly when operated on by-product recovery, citing the well known examples of such practice in England. A careful investigation of the possibilities of bituminous and by-product producers was undertaken and, after a long series of experiments, investigations and consultation with the foremost gas producer builders and producer gas engineers in the United States, a contract was finally given to the Wellman-Seaver-Morgan Co. for five producers and to the Steere Engineering Co. for the equipment for cleaning, cooling and preparing the gas for use in the ovens.

---

*This is the third and last part of a paper read before the American Institute of Chemical Engineers, at Cambridge, Mass., June 20, 1919. See CHEMICAL & METALLURGICAL ENGINEERING, Vol. 21, Nos. 1 and 2, pp. 34 and 88.

The Wellman-Seaver-Morgan Co.'s engineers brought out an entirely new design of gas producer intended to operate on bituminous coal, either with by-product recovery or without, depending on the depth of fuel bed and other special details. The Steere Engineering Co. proposed a gas cleaning plant similar in many details to plants which it had already put in successful operation and also including some new and novel conceptions.

Owing to changes which were made by the gas company in its plans late in 1918, it was not possible to complete the producer gas plant in time for it to be used for the first few weeks' operation of the ovens, and they were therefore started up and run for a few weeks on run of oven gas; thus demonstrating their flexibility and adaptability to widely different conditions of operation and fully justifying the expenditure for including the combination feature.

Patriotic conditions played no small part in forming the decision to adopt a coke oven plant. At the time the contract was let, the United States Government was experiencing a severe shortage of foundry coke and lent considerable assistance toward the construction of this plant, with a view to taking over its entire output of coke immediately on its completion. The uses of the War Department would also have provided an outlet for its production of aqua ammonia from the coke oven gas, sulphate of ammonia from the by-product producer plant and the light oil products from the benzol plant. As the plant did not begin to turn out coke until January, 1919, the demands of the Government no longer existed and other outlets for its products are being found.

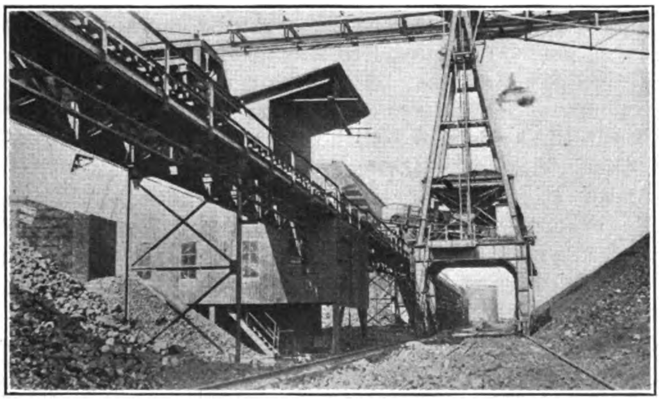


FIG. 20. COAL BELTS ALONGSIDE COAL DOCK AND REHANDLING PLANT

MINOR ADDITIONS TO THE WORKS

In addition to the building of a battery of ovens and the extension of the coal and coke handling apparatus and the apparatus for treating the coke oven gas, many other improvements to the plant had to be undertaken during the past year, which included the erection of a coal store for boiler coal, an administration building, a stocking or rehandling pit for railway coal, the installation of four Coxe stokers for handling inferior grades of boiler fuel, the installation of a new feed water heater and the construction of a storage battery plant to provide power for peak load demands, in addition to the regular output of the works' private power plant.

These minor additions to the works' equipment will be discussed before the description of the oven plant proper, as they were in a sense preliminary to it.

Stocking and Rehandling Pit—In years past, almost all fuel for the gas was received by boat, but disturbed transportation conditions during the year 1918 caused a great deal of all-rail coal to be brought in. Ordinarily this all-rail coal could be handled direct from the cars by means of the telpher buckets, but the above-mentioned unusual conditions made this impossible. A concrete pit was, therefore, constructed at a convenient place under the telpher lines, so that two cars of coal could be discharged by means of hopper bottoms or side dump chutes onto an inclined plane, which carried the coal into a pit directly under the telpher rail, where one or more telpher buckets could readily obtain access to it. This pit has been in constant use during the past year.

Administration Building—The development of the manufacturing department and the unusual amount of repair work during the past year for rehabilitating the plant required more extensive shops and offices than existed. In addition plans were in process of formulation for the development of by-product business and for very careful chemical control of the plant. When the Sassafras Point Works was first built, a portion of the meter house was used as an office and works laboratory, but this was entirely inadequate for the past year and was also situated at a considerable distance from the heart of the works.

It was, therefore, decided to remodel an existing building, the foundations and roof of which lent themselves to such a project. A brick building was, therefore, constructed, containing basement, first and second floors, which is 144 ft. long and 40 ft. wide with an ell 31 ft. wide and 144 ft. long. The basement contains a shop for the repair of automobiles, ample storage room for heavy machinery and parts and very complete lavatories and locker rooms for the shop and office employees. On the ground floor are the superintendents' and engineers' offices and a well equipped machine shop, forge shop and carpenter shop. On the second floor are several large rooms which are now unoccupied but which will later be used for the service of the distribution department. On this floor there is also an instrument room for the storage and care of all sorts of instruments used about the works, library and museum, main chemical laboratory, photographic dark room, photometrical laboratory, coal grinding and sample room, mechanical drafting room and construction engineers' offices.

All parts of the works are connected with the administration offices by means of an intercommunicating Select-O-Phone system.

Coal Handling—A receiving hopper was constructed on the coal bridge to work in connection with a 36-in. belt feeder conveyor. Coal dropped into this conveyor is delivered to conveyors running alongside the coal pile. There are two of these conveyors, serving nearly entire length of the coal pile, some 460 ft., the transfer station being located near the middle of the coal storage space. (Fig. 20.) These 30-in. belt conveyors carry traveling chutes, which take the coal from the feeder conveyor on the bridge. The longitudinal belts deliver to a 30-in. belt conveyor, which takes the coal from the transfer tower to the top of the coal mixing and crushing house. The conveying machinery for coal and coke was furnished by the Robins Conveying Belt Co.

The mixing and crushing building is of reinforced concrete construction with red brick panels and contains a Bradford breaker, two mixing bins, each of 100 net tons coal capacity, a refuse bin of 50 tons coal capacity, a coal mixer and a hammer mill with the necessary electric motors and accessories for the operation of the coal machinery. The outside of the bin walls are faced with common red brick. Steel sash window frames and steel doors are provided. The coal bins are lined with reinforced glass.

The coal coming up from the transfer station is delivered to a 12-ft. x 14-ft. Bradford breaker, where the coal is broken to approximately 1½-in. size, dropping into either of the two bins. One bin is used for high volatile and one bin for low volatile coal. The coal drops from the bins through two chutes onto two coal mixing belts, where the coal is mixed, passing thence into a hammer mill or crusher with a capacity of 100 net tons per hour. This hammer mill may be by-passed, if it is not desired to pulverize the coal. The crusher and Bradford breaker were furnished by the Pennsylvania Crusher Co.

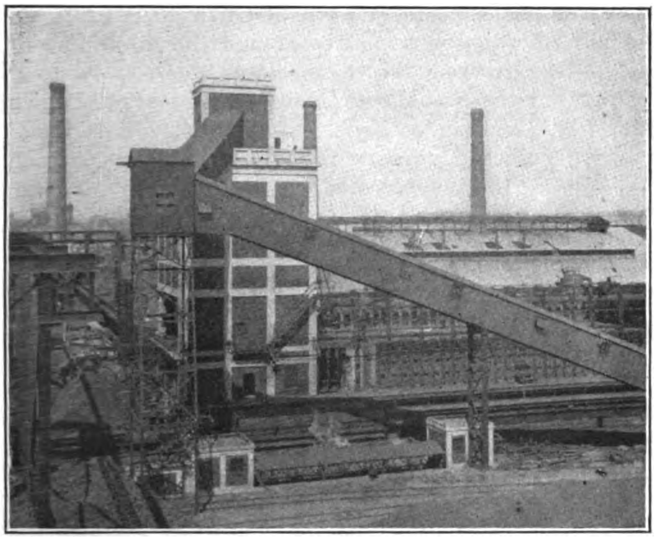


FIG. 21. COAL BIN, OVENS AND CONVEYORS. COKE WHARF IN FOREGROUND

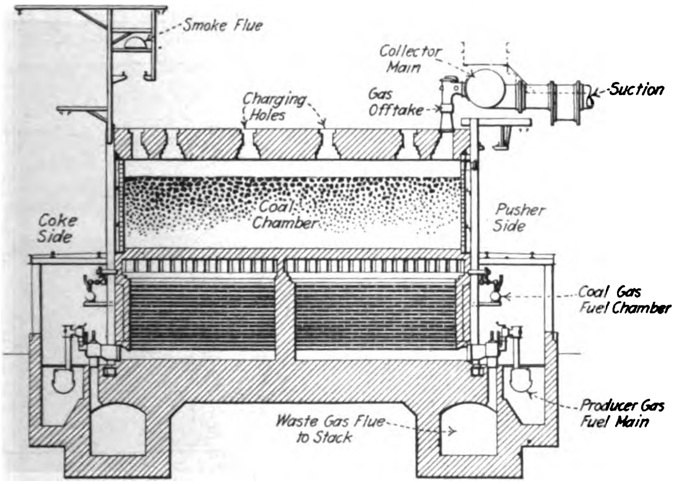


FIG. 22. SECTION THROUGH REGENERATORS AND OVEN

From the hammer mill or the by-pass, the coal drops onto a 24-in. belt conveyor, which delivers the coal to a transfer tower, thence onto another 24-in. belt conveyor to the top of the coal storage bin.

The coal storage bin is built of reinforced concrete and has a capacity of 750 net tons of crushed coal. It has steel sash window frames with double strength glass and steel doors. The hoppers in the bin are lined with glass, and in the bottom of the bin are twelve hoppers arranged in three rows of four, each hopper being provided with a cast iron duplex gate for charging coal into the larry car. The bin is divided into two parts by a partition, so that two kinds of coal may be in storage at the same time, such as straight high volatile or high and low volatile mixture of any desired proportion. The panels on the building are filled with common red brick. A stairway is provided for access to the various parts of the building. (Fig. 21.)

When using a mixture of high and low volatile coal for making foundry coke or hard grades of domestic coke, the hammer mill or crusher is used and the coal is delivered to the coal bin pulverized so that from 80 to 85 per cent will pass a ⅛-in. mesh screen.

When using the straight high volatile coal, it is sometimes desirable to have much coarser coal, and the hammer mill is then by-passed. The capacity of the coal handling equipment is such that 700 tons, or a full day's run, of coal may be put through the plant and into the storage bins in ten hours. It is apparent that should the capacity of the plant be doubled at any future time, the coal handling equipment is sufficient to care for this increase.

Oven Battery—There are forty Koppers patented, cross-regenerative, combination, by-product coke ovens built in one battery, resting on a reinforced concrete pad, with reinforced pinion walls at each end. The ovens have a capacity of 11.4 net tons each and are 37 ft. long from face to face of doors, 9 ft. 10 in. high, 15¾ in. wide at the narrow end and 18¾ in. wide at the wide end. The ovens are 3 ft. 6¼ in. from center to center. All oven brick work exposed to high temperature is silica, the secondary portions being firebrick. Common brick is used to face the regenerators and as fill above the ovens, and the tops of the ovens are covered with paving brick.

The ovens are designed to be operated either as coke ovens, using part of the run of oven gas in the heating flues, or as gas ovens, using producer gas generated in an independent producer plant from coal or coke, and are designed for a 15-hr. coking time. Under each oven is a double generator, the walls between the double regenerators being built under the vertical heating flues and being very heavy and tight. Length-

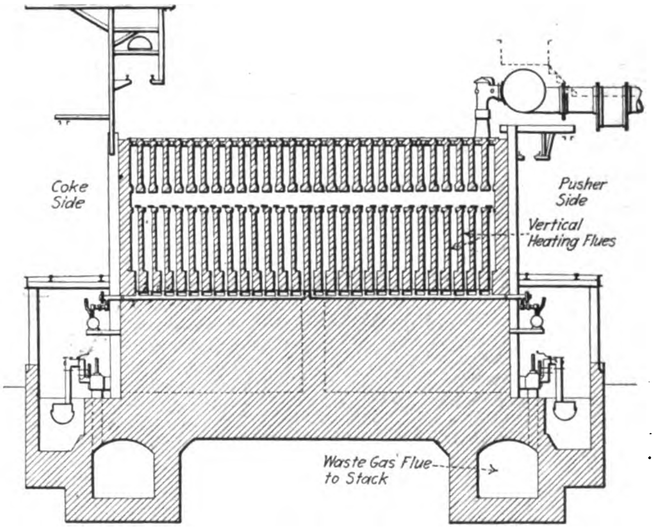


FIG. 23. SECTION THROUGH OVEN HEATING FLUES

wise through the center of the regenerator runs a light division wall. There are two lines of ports entering each flue chamber, one from each of the adjoining regenerators.

One double regenerator is entirely given over to the preheating of the air for combustion, the air from one side of the central division wall going to one set of flues and that from the other side to the next set of flues. The next adjacent double regenerator preheats the producer gas and distributes it in a similar manner, the gas from one side of the central division wall going to one side of the oven and from the other half going to the other side. Thus, any leakage through the narrow division wall is of no importance, as air and gas are separated by the heavy walls under the flues. (Fig. 22.)

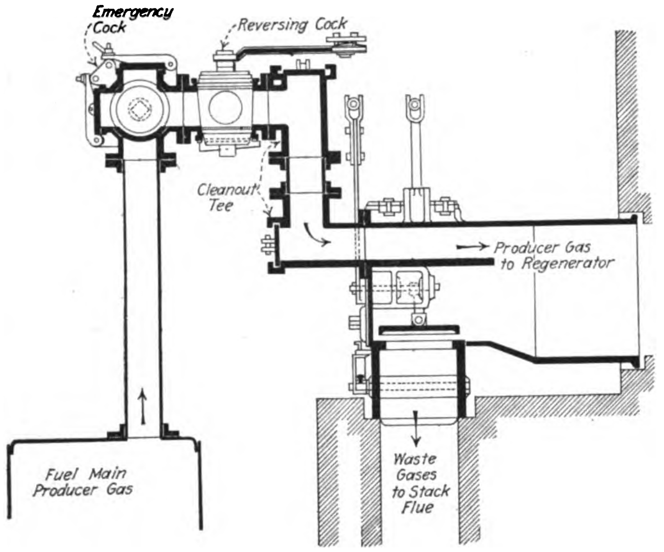


FIG. 24. CROSS-SECTION THROUGH PRODUCER MAIN

When using run of oven gas, the divided regenerators are used for air only. The oven is supplied through a fuel gas main feeding risers which serve the gas ducts just under the flues. This duct is divided into two parts, each serving approximately one-half the oven flues from opposite sides of the battery. At the base of each flue is a removable nozzle, through which the burning gas issues. (Fig. 23.) Combustion is regulated by means of a system of sliding bricks acting as dampers on the vertical flues as they lead into a horizontal flue. Each flue may be regulated independently. Also dampers are provided to regulate the draft in each regenerator outlet. The gas burns in one-half of the flues at a time at one side of the battery, the products of combustion rising to the horizontal flue, passing to the other half of the battery, down through the vertical flue to the regenerators, to the main flue, to the stack. Thus, the regenerators are reheated by the products of combustion on alternate sides of the battery.

The direction of the flow of the oven or producer gas is reversed automatically through the system of burners, flues and regenerators every thirty minutes. Thus, the regenerators return to the flues a large amount of heat which would otherwise be wasted.

The nozzle through which run of oven gas burns is located midway between two rectangular ports, each serving one-half of a generator. When using oven gas, it is not advisable to supply air for combustion to each nozzle from both sides; so it is considered good practice to close with a brick one of these openings, allowing the air from only one opening to mingle with the gas for combustion. The next adjacent gas nozzle is served with air from the opposite side; so that the placing of the bricks closing off the air ports from the regenerators is in a sort of staggered formation. On the other hand, when the producer gas is used, the gas nozzles play no part and are closed and the bricks covering the alternate regenerator ports are removed, and in any given heating flue, one line of ports feeds gas from one-half of a double regenerator and the other line of ports feeds air from the regenerators.

Draft for the ovens is provided by a red radial brick stack 7 ft. 6 in. inside diameter and 200 ft. high. There is a main stack damper, a regulating damper for each flue, serving the two sides of the battery, and a system of reversing valves and dampers. The reversing is done automatically. A time clock, which may be adjusted for any given reversing period, actuates contact devices, which set in motion electric motors, which, in turn, operate the various apparatus concerned with reversal.

When run of oven gas is being used to heat the battery, the reversing machine operates the gas cocks on the run of oven gas lines, but when producer gas is being used, the cocks on the run of oven gas line remain closed all the time, and the reversing mechanism operates the valves on the producer gas lines, handles the dampers on the flues, opening one and closing the other for reversing the flow of products from one side of the battery to the other side, and also, at the proper time, opens the wind boxes which supply the air to the generators. (Fig. 24.)

The oven doors on the pusher side have a secondary leveling door at the top. All doors consist of a cast iron frame lined with firebrick. These doors on the coke side are handled by a Koppers door lifting machine operated by electric motors.

For pushing the coke out of the ovens, a combined pusher, leveler and door lifting machine is employed, carrying a ram which pushes the coke from the oven, a motor rope driven leveling bar to level the coal in the ovens, a door ram to remove the oven doors and a carbon scraper. (Fig. 25.) On the coke side, there is a door machine, which handles the doors, and a coke guide, which is constructed of steel and which directs the movement of the coke across the coke bench into the quenching car. The coke is received in a coke quenching car with a capacity for one oven, which has air operated cylinders for opening the doors. (Fig. 26.) The bot-

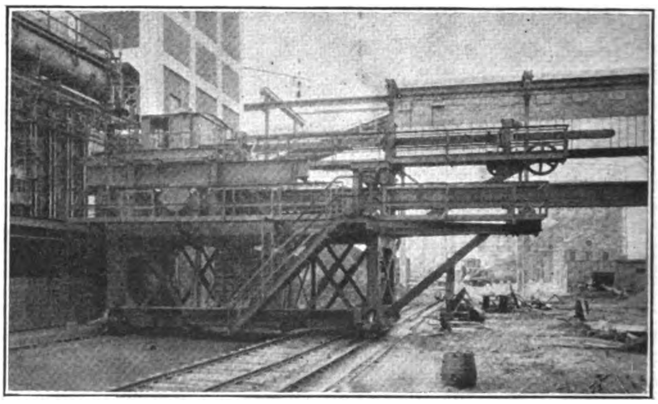


FIG. 25. COKE PUSHER AND LEVELER

tom of the car is lined with cast iron plates and the ends of the car with steel plate. This car is handled by a 15-ton electric locomotive. After the coke is received in the car, it is taken to the quenching station.

For charging the coal into the ovens, there is provided a coal charging larry, electrically driven, which has four coal hoppers made of ¼-in. steel plate. (Fig. 27.) During the charging of the oven, a sort of valve comes down on the coal hole frame, which largely prevents smoke from escaping at this point. The smoke flue extends the entire length of the coke side of the battery and connects with the battery stack. A telescopic pipe mounted on a carriage can be used to connect the smoke offtakes of any oven to any smoke flue through a mushroom valve acting in connection with telescopic pipe mounted on a carriage. Most of the smoke generated during charging can be drawn up through this telescopic pipe into the smoke flue and thence to the stack. The operation of removing the doors, pushing the coke, replacing the doors, charging the coal, leveling same and replacing coal hole lids is accomplished very smoothly and quickly with a minimum of disturbance. Three clay carriers are provided —two on the coke side and one on the pusher side— and as fast as the oven doors are replaced they are luted with clay, which is prepared in a clay mixer located under the coal bin.

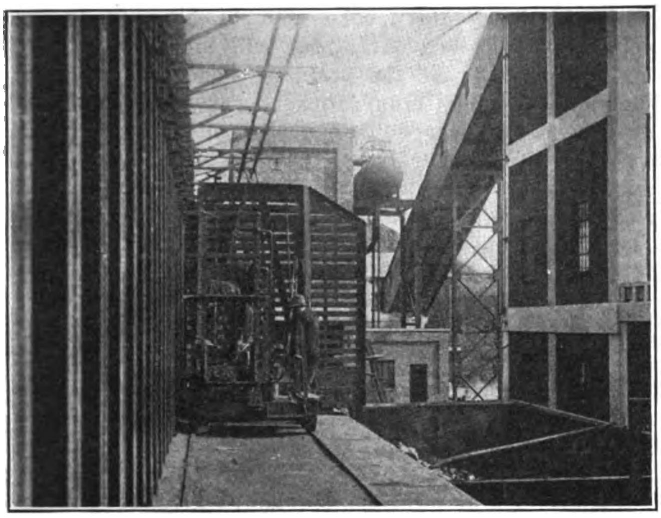


FIG. 26. MUD CAR, COKE GUIDE AND COKE QUENCHER

The run of oven gas, after passing through a wet meter, is brought back to the battery through a 12-in. fuel gas main, a short pipe running from this main to each gas burner, the gas burners being provided with shut-off cocks, carbon caps, etc.

From each oven a short 13-in. cast iron ascension pipe carries the gas from the ovens to the gas collecting main. In the upper section is a butterfly valve and a cleaning door, the ascension pipes entering the collecting main at one side. The collecting main serves the entire battery and is circular in cross section, 54-in. in diameter, sloping from each end to the center, at which point the offtake main connects. This main is provided with the necessary cleaning holes and is built of 3-in. steel plates with a walkway on the top. Sliding plate dampers are provided each side of the offtake main, so that one-half of the battery may be cut off at a time. The offtake main is 30 in. in diameter and is built up of riveted pipe. This main runs over to the producer house wall, supported on a steel bridge. The gas then passes into a down-comer, which is built of two vertical cylinders, one telescoping the other, the outer portion being 4 ft. 4 in. in diameter and 10 ft. long, with a conical bottom, dipping into a seal tank. The inner portion is 30 in. in diameter and 8 ft. 9 in. long. The condensates from the gas and flushing liquor pass down through the down-comer, into the pitch trap and seal tank. The gas passes from the inner pipe to the opening at the top of the larger portion, thence through 30-in. riveted pipe from the top of the down-comer to the ground, then underground to the by-product house. A circulating tank 15 ft. diameter and 9 ft. high built of steel plate with a partition is located at the yard level, this tank being used for supplying tar and liquor for flushing purposes.

Coke Handling—The coke, which is received in the quenching car, is carried to the quenching station, which consists of a quenching and settling basin and a quenching tank. The hood is 20 ft. wide and 50 ft. long and has a total height of 60 ft., being built of brick, open at one end only, so that the quenching car can enter. The water tank is of steel and has a capacity of 7500 gal., being supported overhead on a steel framework about 60 ft. from the ground. A stray pipe is located under the quenching hood. Two motor driven pumps are provided for handling the quenching water, which is recirculated from the sump through the settling basin, etc. The sprays have quick-opening valves and discharge the contents of the tank in 35 to 60 seconds. The coke car, after having received the charge of quenching water, is drawn out from the hood and allowed to stand for a few minutes for draining, the drained water running back into the sump. A small amount of makeup water is required each day to take the place of steam driven off. The quenching hood being some 60 ft. in height throws the rush of steam and vapor high above the yard level. After standing the necessary time, the coke is drawn along the coke road to the coke wharf, which is at the opposite end of the battery from the quenching station. This coke wharf is 48 ft. long and is built of reinforced concrete with cast iron plates and is provided with finger gates and feeders. The coke is fed onto a 36-in. belt conveyor, with a capacity of 40 tons per hour, which runs alongside the coke wharf, then rises to the foundry screening station. The foundry screening station is built of reinforced concrete with red brick panels. The run of oven coke is delivered by the belt conveyor to a rotary grizzly, from

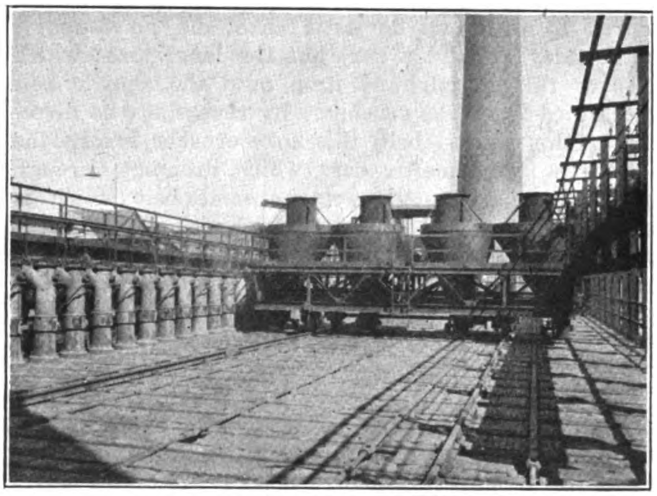


FIG. 27. LARRY CAR AND TOP OF OVENS

which a 36-in. shuttle belt conveyor delivers the foundry coke to open top coke cars on a railroad track alongside. The smaller sizes of coke dropping through the grizzly fall onto a belt conveyor, which ascends to a transfer station, then transferring to another ascending belt rises to the elevation of the telpher lines, passing along under the telpher lines.

Under the telpher lines is a system of rotary grizzlies, which may be operated in several ways. The egg, stove, nut, pea and breeze coke come first to a rotary grizzly, which takes out the egg and drops it into a bay underneath the telpher lines, whence it can be rehandled. The coke then passes to a second set of grizzlies, which take out the stove size, which likewise falls into its proper bay. The nut, pea and breeze then go on a belt to a pit or bin adjacent to the screen houses, where they are, in turn, deposited. From this pit either one of two telphers can pick them up and send them to either of two shaker screen houses, where they are separated into their respective sizes.

Likewise, should the storage piles be full, or if, for any other reason, it is undesirable to separate the egg and stove on the rotary grizzlies, these can be by-passed and all sizes go to the pit, whence they are sent through the shaker screen houses.

FLEXIBILITY OF THE SYSTEM

This makes a very flexible arrangement, so that if the shaker screen houses are down for any reason, the production of egg or stove size is not stopped, as the rotary grizzlies can take care of this; also should the egg and stove piles be well filled under the rotary grizzlies, the shaker screen houses can be called upon to make all five sizes of coke.

In addition to the above arrangement, when foundry coke is not being made or if it is desired to send run of oven coke direct to railroad cars, plates may be put on the grizzly; so that all the coke will drop onto the shuttle belt which goes to the cars. If it is desired to make all domestic coke and no foundry, the foundry grizzly is run, but the large sizes which go over this grizzly and drop onto the shuttle belt are carried to a coke crusher. By reversing the direction of this shuttle belt, this coke crusher breaks the large sizes into domestic sizes, which, dropping through the crusher, are caught on the same belt which is handling those sizes of coke which fell through the foundry grizzly, and thus the whole output of coke in domestic sizes is carried up to the rotary grizzlies under the telpher lines, where the egg and stove are prepared, and also, by the shaker houses, the nut, pea and breeze sizes of coke.

It will be noted that great care has been taken in arranging the coke handling system to avoid tie-ups due to any particular set of conditions, and it is believed that this arrangement will take care of the entire output of coke from the ovens without further additions for some time to come.

The run of oven coke carried by the belt to the foundry screen house is automatically weighed by a Merrick weightometer, so that an accurate weight is obtained on the yield of coke from the coal daily.

After the coke is passed through the shaking screen stations, it drops into bins, from which it can be chuted directly into trucks or wagons or handled into cars, trucks or wagons by the telphers.

A large amount of coke is also handled in paper bags and canvas bags. Small size coke for domestic use is delivered in canvas bags, which are filled in the screening station and placed on a roller conveyor, which automatically transfers them to a wagon loading house, which is 90 ft. long and 29 ft. wide and which will provide ample storage for bags and from which as many as sixteen teams may be loaded at one time. In all as many as forty teams and trucks can be loaded with bag and bulk coke in different parts of the yard, which is considered ample for the domestic trade that is anticipated.

For loading foundry coke, one shuttle belt loader combined with a box car loader will take care of one car to be loaded as the coke is made. Locomotive cranes can also load from storage piles. On the north side of the producer house is a set of track hoppers served by the telpher lines, from which coke may be loaded into four cars at a time for railroad shipment. In addition to this, it is planned to put bins for loading at least two cars under the telpher lines in other parts of the yard, so that in all, including foundry coke and domestic sizes, as many as eight railway cars of 30 to 40 tons capacity can be loaded at any given time.

Condensing and Deammoniating Plant—The condensing plant built by the Bartlett Hayward Co. for handling the 3,000,000 cu.ft. of retort gas consisted of water tube condensers, P. & A. tar extractors and rotary scrubbers. This equipment has been utilized exactly as it stood with the exception of a few minor changes in the movement of scrubber water, liquor, etc. A new exhauster was added, making three in all. Two are used, with the third as a spare. There was ample room in the building for the addition of this third exhauster.

It became necessary to provide gas treating apparatus for 4,000,000 cu.ft. of gas to take care of the total of 7,000,000 which it was contemplated the new coke ovens would produce. Various systems were considered. Had the conditions in the industrial world been normal and the prices such as to make the investment reasonable, it is probable that a complete new by-product plant would have been built, probably of the Koppers system, but funds were not available for such a development at the time and it was felt that the extension of this part of the plant must be made as economically as possible. The Steere Engineering Co. of Detroit had in the past few years developed a system of handling gas for condensing and deammoniating, which had previously attracted the writer's attention and which appeared to be a possible solution of the present problem. The engineers of the Steere Engineering Co. were invited to study the local situation and prepare plans for condensing and deammoniating equipment, which were duly completed and submitted and, with some slight changes, accepted by the company. The gas coming from the ovens in an underground main divides between the old primary condensers and the new Doherty washer cooler as designed by the Steere Engineering Co.

This washer cooler consists of a steel plate shell 5 ft. in diameter and 29 ft. high, packed with wooden grids after the manner of the tar scrubber. Over these grids liquor is circulated by means of electrically driven centrifugal pumps. The gas then passes through the exhausters and tar extractors and again divides, the proper proportion going to a secondary washer cooler, where the temperature is brought down as low as 60 deg. F. if desired. The wash liquor which is pumped over the grids in the washer cooler goes from the base of the coolers through a series of cooling coils, which are set up in a convenient location adjoining the building. Cold water runs down over these cooling coils from suitable troughs and the cooling of the recirculating wash liquor is thereby quickly and economically effected by means of direct contact between the cold incoming wash liquor and the gas. Very complete transfer of heat is secured and the heat potential is much less than with multitubular water condensers.

SATISFACTORY WORK BY WASHER COOLERS

The operation of these washer coolers is highly satisfactory. The condensed liquor and tar from them forms a surplus, which overflows from the base of the scrubbers through a seal to the main tar liquor separators for the ammonia storage wells. After leaving the secondary washer coolers, the streams of gas again come together and pass through the old Feld washer, thence through the two rotary scrubbers and finally through the intensive scrubber supplied by the Steere Engineering Co. This intensive scrubber is 15 ft. long, 6 ft. 6 in. wide and 22 ft. high and contains four compartments filled with wooden grids, over which the wash liquor is circulated by means of four motor driven centrifugal pumps. Fresh water is admitted to the last compartment and the wash liquor is recirculated in this compartment, then passing progressively through each of the other three compartments, finally discharging to a tank in the condenser house, underneath one of the rotary scrubbers. From this tank the liquor is picked up and recirculated through the two rotary scrubbers, the effluent discharging into a second tank located underneaath the other rotary scrubber. From this tank liquor is picked up by a steam pump and recirculated through the Feld washer, the final affluent discharging into the main ammonia storage well.

This system of recirculation of the ammonia liquor results in scrubbing out considerable portions of hydrogen sulphide and carbon dioxide in combination with the ammonia gas and is remarkably efficient in recovery of ammonia. Tests show that when using 1½ gal. of water to a thousand cu.ft. of gas, not more than one grain of ammonia per 100 cu.ft. of gas is lost at the outlet of the intensive scrubber. The liquor through the entire plant, including suction main, condensers, washers and scrubbers, may be made of any desired strength between 1 and 2 per cent by varying the amount of fresh water entering the intensive scrubber. Although the washer cooler and the intensive scrubber appear very small in size for the work which they have been called upon to do, careful tests show that they are amply large and since starting up have worked with great satisfaction.

Molybdenum Steel in the U. S.

During the past 18 months about 50,000 tons of molybdenum steel has been made in this country with very encouraging results, and it is now understood that some of the leading alloy steel makers believe that steel containing a relatively small quantity of molybdenum is superior to any other known material for high-grade aëroplane parts, such as crank shafts. The other alloying metals making up the steels are variously reported as nickel, vanadium and chromium.

Cementing Jamb Joints

IN THE operation of the 40 Koppers coke ovens recently installed by the Providence Gas Co., the method used to seal effectively the joint between fire clay and silica brick construction, where the tenth[1] in. per ft. difference in expansion ordinarily would disrupt the joint and cause leakage, may have wide applicability. The size of each coking section is 40 ft. by 17 in. and the time required for coking approximately 15 hours.

Where brick work was subjected to highest temperatrue the finest grade silica brick was used. For face, top and checker brick, as well as oven floor, fire clay brick was employed. At the junction point between the silica and fire clay brick the difference in coefficient of expansion of the brick requires the use of cement which will seal the slip joint firmly and prevent leakage. Diagram of this joint is shown in Fig. 1.

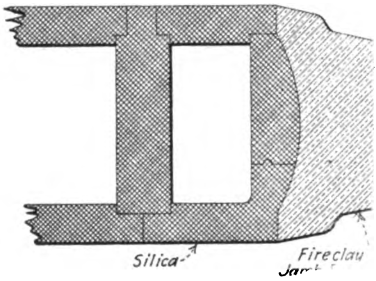


FIG. 1. SLIP JOINT JUNCTION

After trying several mixtures it was found that the best results were obtained by the use of hytempite, a high temperature refractory cement furnished by the Quigley Furnace Specialties Co., Inc., of New York.

A spraying device as shown in Fig. 2, being a modified type of paint sprayer made by the Spray Engineering Co. of Boston, is employed using hytempite as follows:

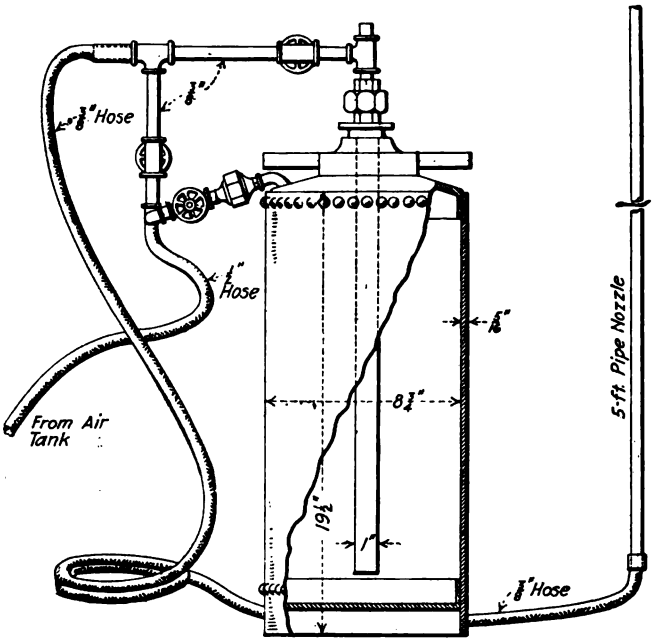


FIG. 2. APPARATUS FOR SPRAYING DILUTE HYTEMPITE INTO THE JAMB CRACK

Dissolve hytempite in warm water in the proportion of 1 pail of hytempite to approximately ¼ pail of warm water. Stir and mix well. Pass through $\frac{1}{16}$-in. wire mesh into the container used for blowing solution into the jamb crack.

---

[1] Fire clay brick, 0.075 in. per ft.; silica brick, 0.175 in. per ft. at 2200 deg. F = Δ 0.1 in. ft.

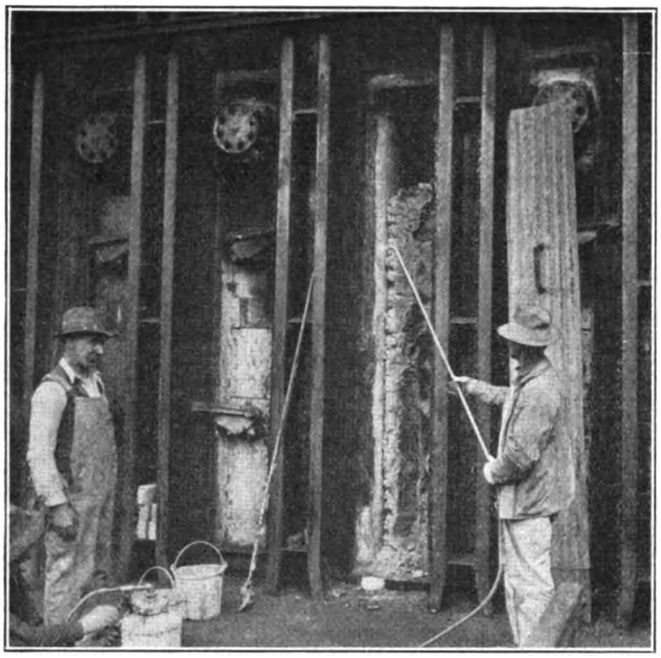


FIG. 3. DETAIL SHOWING SPRAYING JOINT WITH HYTEMPITE

Clean face of jamb bricks thoroughly, also clean the rougher material from jamb crack, with the steel tool provided for that purpose. Then apply full air pressure, approximately 50 lb., through the pipe used for patching, cleaning crack thoroughly before applying the solution of hytempite. Then turn air into the hytempite container, being careful not to use too much air pressure, open proper valves and apply solution to the crack by means of the pipe and hose which are provided. See Fig. 3.

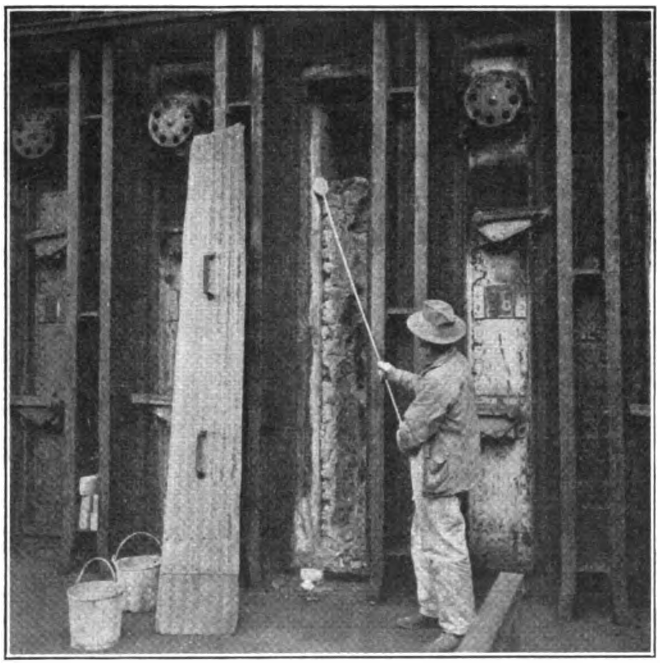


FIG. 4. FINISHING OFF WITH TROWEL

After the crack has been filled with the solution, if any portion of it remains open, smooth over with neat hytempite, using long handled trowel. By using a corrugated shield as shown in Fig. 4 the operator is enabled to carry on repairs while ovens are hot.

Mining and Metallurgical Situation in Belgium in 1919

THE first official data on the situation of the Belgian industries at the beginning of 1919 have just reached this country. The latest issue of the *Annales des Mines de Belgique* received here contains a report of the investigation instituted by the Belgian Department of Industry and Labor on some mining and metallurgical industries.[1] The following is a short abstract of this report:

COAL MINING

It can be said that of all the Belgian industries this is the one which has suffered the least from wanton destruction. This is explained not by the thought that the Germans had any consideration for the Belgians and their coal industry, but by the fact that during the first four years of the war they treated the coal mines as theirs, and only the lack of time during the last few months of the war saved the Belgian mines from the fate of the mines in northern France.

The mining situation is best shown by Table I, which gives the production for 1913 to 1918 by coal districts and totals.

TABLE I—COAL PRODUCTION IN BELGIUM, METRIC TONS

Year	Mons	Centre	Charleroi	Namur	Liége	Total
1913	4,406,550	3,454,640	8,148,020	829,900	5,998,480	22,841,590
1914	3,578,840	2,701,550	5,764,410	534,180	4,135,070	16,714,050
1915	3,310,200	2,573,430	3,875,690	410,660	4,007,520	14,177,500
1916	3,705,540	3,212,860	5,223,970	497,150	4,223,350	16,862,870
1917	3,869,680	2,785,400	4,671,240	437,870	3,155,510	14,919,700
1918	3,281,720	2,559,610	4,493,630	374,440	3,112,530	13,821,930

In the new coal district of Campine, which was ready to start actual mining Aug. 4, 1914, and from which the Belgians reasonably expected to get the needed additional fuel, the total mining amounted to 11,640 tons in 1917 and 65,670 tons in 1918.

COKE

Of the Belgian coke ovens it is stated: Some have been in operation without the needed repairs, some have been totally destroyed (especially those of the Cockerill plants) and the remainder have been totally dismantled, and the installations for by-product recovery carried away or destroyed.

The results of this policy are shown in Table II, which gives the production, 1913-18, by provinces and totals.

TABLE II—COKE PRODUCTION IN BELGIUM, METRIC TONS

Year	Hainaut	Liége	Other Provinces	Total
1913	2,220,180	877,130	445,690	3,523,000
1914	1,406,460	595,210	?	2,001,670
1915	424,460	90,140	?	514,600
1916	667,530	124,820	?	792,350
1917	648,210	27,830	?	676,040
1918	509,150	13,060	?	522,210

IRON AND STEEL INDUSTRY

This industry has suffered more than any other. Were it not for the figures given in Table IV, it would be difficult to realize the fate which has befallen the industry which was the pride of the Belgians. The list of examples of destruction includes every district in every province, and the once well-known skilled Belgian metallurgist is forced to labor—not only for the present, but for many years to come—with pick and shovel, in order to clear away the ruins and rebuild the plants.

---

[1] La situation des Industries en Belgique, en février 1919, après les dévastations, allemandes. *Annales des Mines de Belgique*, 2ème livraison, Tome XX, 1919, pp. 695-711.

TABLE III—IRON AND STEEL PRODUCTION IN BELGIUM, METRIC TONS

Year	Hainaut	Liége	Namur	Other Provinces	Total
1913.........	1,189,650	896,360	31,030	107,020	2,224,060
1914.........	641,560	519,860	14,870	62,490	1,547,410
1915.........	76,590	85,580	......	2,200	164,370
1916.........	130,945	90,260	......	2,130	200,821
1917.........	....	....	......	....	....
1918.........	....	....	......	....	....

BRIQUETTES

The Belgian railways use briquetted fuel exclusively. which accounts for the fact that the briquetting plants were in most cases unharmed.
totals.

Table IV gives the production for 1913 to 1917 by provinces and totals.

TABLE IV—BRIQUETTE PRODUCTION IN BELGIUM, METRIC TONS

Year	Hainaut	Namur	Liége	Other Provinces	Total
1913.........	1,864,200	171,010	453,350	120,000	2,608,640
1914.........	1,371,480	128,730	299,490	?	1,799,700
1915.........	968,470	135,220	386,410	?	1,409,100
1916.........	1,300,850	166,710	468,260	?	1,935,820
1917.........	707,690	70,130	204,110	?	981,930

ZINC AND LEAD

The place occupied by Belgium in these industries about five years ago is well known, but today Table V shows what premeditated destruction can accomplish.

TABLE V—ZINC AND LEAD PRODUCTION IN BELGIUM, METRIC TONS

Year	Zinc		
	Ingot	Rolled	Lead
1913............................	204,220	51,490	103,480
1914............................	145,925	30,780	70,980
1915............................	51,660	21,350	16,770
1916............................	22,930	8,045	15,560
1917............................	10,290	1,675	22,745
1918............................	......	.....	......

The report contains, among other examples of destruction, the case of the plants of the Dumont Frères Co. of Sclaigneaux (near Liége). These plants, especially the lead plants, which had been thoroughly modernized shortly before the war, have been completely dismantled, and all the machinery and even the roof trusses have been shipped away.

The grim comparative statement is made that the metallurgical plants of Hoboken (near Antwerp) and Overpelt, which are owned by German capital, are now in just as good working condition as ever.

Synopsis of Recent Chemical and Metallurgical Literature

Present American Acid Bessemer Process—RICHARD S. MCCAFFERY, professor of metallurgy, University of Wisconsin, published in the January issue of the *Wisconsin Engineer* a paper presenting his conclusions on the reversibility of manganese oxidation. He starts from a consideration of the data given in Table I.

With a gradually increasing heat, manganese carbide burns to MnO and CO_2. However, if hot-pig or high-silicon iron is blown, the temperature runs up so rapidly that MnC_2 is retained in the bath to the end since under these conditions this compound will produce CO rather than CO_2. Any manganese carbide retained acts as a powerful reducer, returning silicon to the bath, and reducing Fe_3O_4 to FeO, forming a more basic, infusible slag containing ferrites, which is largely responsible for the excessive spitting of a hot blow. Under these circumstances there appears to be residual manganese in the steel, not on account of the reversibility of the reaction $2Mn + O_2 \leftrightarrows 2MnO$, but on account of the fact that the carbide is residual. In this case silicon is always residual as well. (Of course when it is said that iron silicide burns first, it means that a number of reactions are taking place at the same time, but that this reaction predominates.)

TABLE I

Substance	Formula	Oxidation Products	Calories per Gram Atom of Metal
Silicide of iron........................	FeSi	Fe_3O_4; SiO_2	245
Carbide of manganese..............	MnC_2	MnO; CO_2	171
Silicide of manganese.............	Mn_7Si_2	MnO; SiO_2	135
Carbide of iron........................	Fe_3C	Fe_3O_4; CO_2	98
Carbide of iron........................	Fe_3C	Fe_3O_4; CO	75
Carbide of manganese..............	MnC_2	MnO; CO	35

Since it was desired to find some remedy for the excessive spitting, this could evidently be reduced by close temperature regulation. This in turn could be done by three different methods: first, by charging cold scrap—which was not always available; second, by blowing steam through the tuyeres—which was costly, and third, by increasing the number of tuyeres and reducing the air pressure. Quite often the high air pressure drove oxygen clear through the metallic bath during the carbon blow, and this unconsumed oxygen burned CO to CO_2 within the shell, thus increasing the temperature of the bath and the air cost. Therefore, at the author's suggestion the number of tuyeres was increased from 23 to 35, and the blast pressure dropped from 28 to 22 lb. When running on successive heats from the same mixture the modified converter reduced the blowing time from 14 min. to 10 min. 20 sec., saved 40 per cent of blowing engine power, and entirely reduced the spitting.

Book Reviews

OPPORTUNITIES IN CHEMISTRY. By *Ellwood Hendrick*, Consulting Editor, CHEMICAL & METALLURGICAL ENGINEERING. x + 102 pages. New York: Harper & Bros.

This book is one of a series intended to aid the returned soldier in vocational rehabilitation by pointing out the possibilities afforded by different industries. While written primarily for this purpose, this little book is admirably adapted to serve as an introduction to the author's larger work, Everyman's Chemistry, and thus to stimulate popular interest in the study of chemistry as an important adjunct to all branches of business activity. The style is intimate and conversational, so that the reader follows with interest expositions of processes and theories which, treated in text-book fashion, would prove unattractive to the general reader.

Beginning with a short outline of certain fundamental concepts, such as elements, atoms, molecules and electrons, the reader's attention is directed in turn to the great cycle of nature, by virtue of which the sun's energy is locked up in growing vegetation; the activities of the soil—invisible to the naked eye, yet responsible for the growth of crops; the mysteries of catalysis; the chemist's tiny allies—the yeasts, molds and bacteria; the manufacture of soap and its application in the laundry business; the earth as raw material and, finally, iron and steel.

It is doubtful if anyone can read the book without feeling an increased interest in chemistry, not only as a science in itself, but as an aid to the better understanding of one's own business and, to quote the author in conclusion, "After all, that is the most important part of a man's working life—that his job shall be interesting to him."

Alan G. Wikoff.

Personal

Mr Warren F. Bleecker of Boulder, Colo., was in New York recently.

Mr. R. V. Cook, recently research engineer with the Koppers Co. of Pittsburgh, has joined the sales-engineering staff of the Brecht Co., St. Louis, Mo. He will have charge of the sales and erection of the new Brecht standard oil-hydrogenating plant which has just been introduced.

Mr. William E. Corey, chairman of the Midvale Steel & Ordnance Co., has been elected a director of the Sinclair Consolidated Oil Corp.

Dr. F. G. Cottrell, chief metallurgist in the U. S. Bureau of Mines, has been named assistant director in charge of investigative and scientific work. Other changes in the Bureau are the appointment of the former chief clerk, **Mr. F. J. Bailey**, as assistant to Director Manning in charge of executive work, and **Mr. H. W. Meyer**, chief clerk of the War Minerals Relief Commission, to be chief clerk of the Bureau, succeeding Mr. Bailey.

Mr Algernon Del Mar, milling and flotation engineer, has opened an office at 1424 Alpha St., Los Angeles, Cal., and will conduct a business in the design and operation of milling plants.

Mr. R. C. Gemmell, general manager of the Utah Copper Co., will become assistant managing director of that company and other interests of D. C. Jackling, effective Aug. 1. Besides the Utah Copper Co., Mr. Gemmell will assist in the direction of the Nevada Consolidated Copper Co., Ray Consolidated Copper Co. and Chino Copper Co. **Mr. Louis S. Cates**, at present general manager of the Ray Consolidated Copper Co., will become assistant general manager of the Utah Copper Co. on Aug. 1, with offices in Salt Lake City.

Mr C. W. Hare, director of sales, War Department, sailed for Europe July 21 with a party of 22 to ascertain European conditions for the disposal of surplus property now held by the War Department in the United States.

Prof. Samuel Hoyt has resigned as assistant professor of metallography, University of Minnesota, Minneapolis, to accept a position as metallographist for the National Electric Lamp Association, Nela Park, Cleveland.

Mr. **D. S. McAfee**, engineer of the Dorr Co., has returned from Chile.

Mr George Mesta, president of the Mesta Machine Co., Pittsburgh, has sailed for Europe on a pleasure and business trip combined, to be gone until November.

Mr Lewis A. Parsons has resigned from the International Nickel Co. of Canada and accepted a position on the *Mining and Scientific Press* as associate editor.

Mr. William C. Potter, of Guggenheim Bros., is a member of the board of directors of the Mexican International Corporation, recently organized to finance new enterprises in Mexico.

Mr. Thomas T. Read, formerly associate editor of the *Mining and Scientific Press*, has joined the staff of the Bureau of Mines and will investigate the work of the Bureau in relation to public welfare.

Major F. H. Schoenfess, lately discharged as metallurgical expert from the United States Ordnance Department, where he had charge of the specifications for the heat-treatment of all parts of various types of guns, has become associated with John H. Brewster, 30 East 47th St., New York City, American representative of the Fagersta Steel Co., Fagersta, Sweden, maker of carbon and alloy steels.

Mr. W. H. Staver, mining and metallurgical engineer, of New York City, is on a business trip to Denver and other points in the West.

Dr. Samuel A. Tucker, formerly professor of electrochemistry at Columbia University, who served as Major in the Chemical Warfare Service, is now chief chemist for the Chemical Foundation, Inc.

Mr. C. H. vom Baur has resigned as vice-president of the T. W. Price Engineering Co., Woolworth Bldg., New York, and will soon establish an office for the sale of the vom Baur electric furnace.

Mr. M. W. von Bernewitz has resigned as assistant editor of the *Mining and Scientific Press* and has come to New York to collaborate with Walter H. Weed on the Mines Handbook.

Mr C. M. Weld, consulting mining engineer, has returned from war work in Washington, and resumed practice with offices at 66 Broadway, New York.

Major Clarence J. West, recently in charge of the editorial department, research division, Chemical Warfare Service, has joined the staff of Arthur D. Little, Inc., Cambridge, Mass., as director of the information department. While with the Chemical Warfare Service he prepared about fifty monographs on different phases of chemical warfare, dealing particularly with war gases, smokes, incendiaries, absorbents, etc. In his new position Major West will extend the library facilities of the organization and develop a special information service on technical and scientific subjects.

Obituary

Mr. Clarence W. Hathaway, metallurgist for the last eight years for the Granite City Steel Works Branch of the National Enameling & Stamping Co., met his death by drowning while swimming with a party of friends in the Mississippi River on July 19 at Granite City, Illinois. He was born in Columbus, Ohio, in 1886, and was educated in the schools of that place and at the Ohio State University, Columbus, Ohio. He had previously been employed with the U. S. Steel Corporation at Gary, Indiana, before accepting his last position. He leaves a wife, father and mother, one brother and four sisters. Mr. Hathaway was a member of the Masons and Elks; and of the American Chemical Society, Metallurgical Society of America, and the American Ceramic Society.

Current Market Reports

Tuesday, July 29.—The general rise in prices noted in the last report has continued during the past fortnight, due to an increase in both the export and the domestic demand.

Lead:—The price has advanced to 5.85-6.00c. for New York delivery and 5.50-5.75c. for East St. Louis shipment.

Tin: — London prices have advanced almost daily, Straits, spot, being now quoted at £272 per ton. The general New York quotations on Straits, spot, is 71c.; electrolytic, 99 per cent, 66½-68c. Tin ore is arriving in ever-increasing amounts. During the week of July 14-21, 1850 tons were received from Bolivia.

Zinc:—Spot spelter continues to advance. East St. Louis, 7.70-7.80c.; New York, 8.25c.

OTHER METALS

Bismuth	lb.	$3.10 —	......
Cadmium	lb.	1.50 —	1.75
Cobalt	lb.	2.50 —	3.50
Magnesium	lb.	1.75 —	2.10
Mercury .75	lb.	109.00 —	......
Nickel	lb.	.41 —	.45
Iridium	oz.	175.00 —	......
Palladium	oz.	115.00 —	120.00
Platinum	oz.	105.00 —	110.00
Silver	oz.	1.07½ —	......

Aluminum:—The market is reported quiet and 98-99 per cent ingots are now quoted at 33c. lb. Scrap continues to advance: Cast, 23-24c.; sheet, 24-25c.; clippings, 26-27c.

Antimony:—It is reported that considerable export trade to Europe has developed and the market has therefore assumed a much firmer aspect. The present quotation for spot regulus ranges from 9¼-9½c.

Copper:—The rapid rise in the copper market during the past few weeks has brought the price for spot delivery to 23½c. Buyers who have bought copper for a rise now see enough profit to let go of some of their holdings, and this has stopped the further upward movement for the time being. Quotations are: Spot and July, 23¼-23½c. August, 23½-23¾c.; September, 24c.

Copper sheets, hot-rolled	lb.	33.50 —	......
Copper sheets, cold rolled	lb.	35.00 —	......
Copper bottoms	lb.	41.50 —	......
Copper rods	lb.	24.75 —	$25.00
Copper wire	lb.	26.00 —	......
High brass wire and sheets	lb.	27.75 —	......
High brass rods	lb.	26.75 —	......
Low brass wire and sheets	lb.	30.50 —	......
Low brass rods	lb.	31.25 —	......
Brased brass tubing	lb.	39.00 —	......
Brased bronze tubing	lb.	44.25 —	......
Seamless copper tubing	lb.	37.75 —	......
Seamless bronze tubing	lb.	44.25 —	......
Seamless brass tubing	lb.	36.00 —	......
Scrap, heavy machinery comp		18 —	19
Scrap, heavy and wire		18½ —	19½
Scrap, light and bottoms		18 —	17
Scrap, heavy, cut and crucible		20 —	21½
Scrap brass, heavy		12 —	12
Scrap brass, casting		13¼ —	14
Scrap brass, light		10½ —	11¼
Scrap, No. 1 clean brass turnings		11 —	11½
Scrap, No. 1 comp. turnings		16 —	17

The Iron and Steel Market

When the seasonal correction is applied to the reading given by the order books of the steel mills a very favorable showing is made of the strength of the market. July and August are normally very dull months in the steel trade, but this year the volume of domestic business is showing for July a slight gain over June. In export business this is not the case, there being somewhat less activity, but that is undoubtedly due to causes other than the season, and beyond the control of the steel trade.

The trends of steel mill activity are well shown by proportioning the ingot production, reported monthly, to an estimated capacity of 49,000,000 gross tons per annum. This gives the following percentages of activity, as averages for the months: January, 87 per cent; February, 85; March, 77; April, 65; May, 54; June, 67. The low point fell in May, which, with an average of 54 per cent for the month, must have had a low point at about the middle of the month of approximately 50 per cent. June, with a sharp increase in total production, must have had a rate of about 70 per cent at the close of the month. The rate has probably not increased materially since the first of July. The July average, when reported, will probably lie between 70 and 75 per cent.

STEEL TRADE CONDITIONS BECOMING MORE NORMAL

Conditions affecting the steel trade have altered toward the normal by a sufficient amount to justify a long-range scrutiny to determine when and how full activity in the industry may be developed. Early in the year the tonnage turned out by the mills constituted no index to the future, as the industry seemed to be running on momentum to an extent. Just why it operated as well as it did cannot readily be explained, nor if the explanation were available would it be of particular value as a foreshadowing of what should be expected for the future. The fact that the low point in steel production fell six months after hostilities were terminated by the signing of the armistice indicates very plainly that what occurred in the fore part of the intervening six months could not be indicative of what would occur in the trade later.

Assuming that the steel industry has operated in July at a rate of producing 35,000,000 tons of ingots a year, which is 70 per cent of an estimated capacity of 49,000,000 tons, this 35,000,000 tons is equal to what may be estimated as the entire capacity in 1914, there having been a 40 per cent increase in steel producing capacity, though hardly in steel finishing capacity, during the war. In both 1912 and 1913, easily the best pre-war years from a tonnage standpoint, ingot production was about 30,280,000 tons. Thus production in July was 16 per cent in excess of the best sustained average before the war. Exports of steel and steel manufactures, reduced to an ingot basis, represented about 3,000,000 tons a year in 1912 and 1913, and represent about 5,500,000 tons at present, and thus one has it that production of ingots for purely domestic consumption is now at about two and a quarter million tons a year, or about 8 per cent, more than in 1912-13.

INDIVIDUAL CASES OF STEEL CONSUMPTION

With this general guide as to total tonnages, one may readily compare individual cases of consumption. The automobile industry is consuming much more steel than ever before, and so is the petroleum industry, for the lap weld departments of the pipe mills are filled with orders for practically the remainder of the year, although their orders outside the petroleum industry have been distinctly light. Dwelling house construction is, or soon will be, fully up to a normal rate. Construction work involving large projects, skyscraper hotel and office buildings, bridges, power plants and factories is far below normal, although steadily increasing. Shipbuilding is at the rate of about 500,000 tons deadweight a month, and that may prove to be the normal rate for several years, but lately shipbuilding has been largely with steel accumulated during the war as a factor of safety, so that later on the shipyards will be calling for more steel from the mills. Railroad buying is completely absent. The normal proportion of railroad consumption of steel to total steel poduction has usually been exaggerated, some estimates having been as high as 30 or 40 per cent. A liberal estimate seems to be 20 per cent, with a 5 per cent leeway in either direction.

From this rough sketch it is readily seen that demand has opportunity to grow from its present volume by an amount easily sufficient to take up the slack between the present 70 per cent operation and a full operation, and that without any increase in export demand.

EXPORT DEMAND

It would be quite unsafe to count upon an increase in export demand, particularly as the export bookings in July ran below those of June. The purchasing power in foreign countries is limited and in Great Britain and on the Continent exchange rates are very unfavorable. The condition is one that the steel industry itself can do little to rectify, but one that the United States, or the American people, can and should entirely rectify. We have been expecting financially impoverished nations to buy goods from us because we have goods, ignoring the fact that when we have much more money than they we should also buy from them. As a matter of self-interest the steamship companies, desiring return hauls, will probably do much to encourage an import trade, and the divergence in exchange rates will also have a favorable influence.

There is little likelihood that steel prices will change much during the remainder of this year. It is now practically assured that there will be no declines in important commodities, with the possible exception of plates, where there is so great an excess of capacity. The market has successfully stood the test of there being a period of price cutting, in which the mills with the leanest order books bought their way into the market and then resumed quoting full prices. As to advances, there is less sentiment among steel mills in favor of making advances than there was a month ago. With a larger volume of business they are better satisfied with existing prices, which are those that became effective March 21, and they have come to realize that advanced prices, perhaps of doubtful benefit in themselves, would probably precipitate labor unrest and might easily lead to advanced wages. The advanced wages would be permanently fastened on the industry, while the advanced prices might yield at any time. Here and there an independent steel producer has advanced prices on one product or another, but these advances have not taken hold generally and are not especially popular.

The Chemical Market

New York, July 28, 1919.

The increasing foreign demand has stiffened and stabilized the entire line of heavy chemicals. Among those most urgently sought are *sodium bichromate* (by England and South America), and *caustic soda* (by Japan and South America). In addition to this, it is reported that a number of domestic contracts have been placed for these two products, covering the balance of the year. *Sodium bichromate* is probably the strongest item on the list, having advanced 37 per cent since last writing, present price being 11-12c. Not long ago it was selling below cost.

Caustic soda continues to mount, under the guidance of the United States Alkali Association, which has just boosted the export price from $3.30 up to $3.50 per cwt., f.a.s., New York. *Muriatic acid* has risen ½c., because of curtailed production and short stocks. As for *potassium prussiate*, there are only two tons on the market to-day, with the price 55-65c. against 40-50c. two weeks ago. It is expected that stocks will shortly be repleted, with relief to the buyers and sellers alike.

Copper sulphate (*blue vitrol*) reflects the present higher price of copper. However, although the price for moderate quantities is $9.15-$9.25 and quoted at $9 for carloads, it is possible to obtain the latter at $8.75 per cwt.

NAVAL STORES

Except during the Civil War, turpentine and rosins were never higher than at present. Both are selling heavily in foreign markets as well as in the domestic, with the result that spot stocks here are scarce. At this writing spirits of turpentine is quoted at $1.27 per gal., against $1.05 two weeks ago. During the war, Europe produced practically no naval stores, so is now buying heavily in this country. Another factor of importance in explaining high prices is the tie-up of coastwise shipping, which affects the ports of New York, Boston, Savannah, New Orleans, Galveston and Norfolk.

VEGETABLE OILS

The speculative feature, which for many weeks has characterized the vegetable-oil market, is beginning to disappear. What little oil there is, is in the hands of manufacturers and wholesalers who, under present conditions, are in no hurry to sell. It is believed in some quarters that vegetable oils have attained the apex. No advance is expected unless a heavy buyer enters the market. This opinion is substantiated by the fact that the purchase of only 660 bbl. of soya bean oil last week sent the price up a cent.

Is the present price of linseed oil too high? Well, it was never higher—even during the stress of war. Shortage of seed is the reason given, but there are dealers who admit that inflation is a still better reason. In the first week of June raw in 5-bbl. lots sold for $1.59 per gal.; second week, $1.83; third week, $1.90; first week of July, $1.90; second week $2.15; third week, $2.20—an increase of 38 per cent in less than two months. It would seem that linseed oil has succumbed to the speculative fever that has been ravaging the vegetable-oil market for some time.

As a result of increased domestic consumption soya bean oil has advanced in price, which now is 18c. per lb. in tank cars, f.o.b. Pacific Coast, as compared with 16¾-17¼c. at the last writing. It is expected to go even higher, due to lax buying in the Orient. Domestic demand is quickening.

Castor oil should advance sharply in the near future, owing to the usual fall demand by the textile mills and tanners. No castor beans are being grown in the United States this year, necessitating entire dependence on Brazil. Brazil has already shipped large quantities of seed to France.

St. Louis, July 23, 1919.

The fertilizer manufacturers, who started the original heavy demand for 60 per cent *sulphuric acid*, have kept up their demands so insistently that the price is expected to rise within the next few weeks. One local producer put a new plant in operation the first part of the month and already is swamped by orders. The price holds steady at $12 a ton.

The 66 per cent *sulphuric* is normal, demands being steady but not heavy, the price remaining at $18 a ton. The demand for *oleum* also is normal and the price remains the same.

Muriatic acid is in immense demand. Producers are frankly at a loss to know where the supply is going and why orders should be so heavy. One producer believes that a shortage of tank cars is being felt, which is causing buyers to place numerous orders in the hopes of getting through the amount of muriatic they desire. Prices hold steady at $22 a ton for 18 per cent.

Sodium bisulphate (niter cake) is reported oversold. Orders are being refused by some local producers who have their supply contracted for until Jan. 1. The price is $2.50 a ton. Steel manufacturers are still buying heavily for pickling purposes.

Zinc chloride is extremely active. One local producer reports sending a million pounds in July to a customer who formerly bought only 1,500,000 lb. in a year. The price is 3¾c. a lb. on contract and 4c. on the open market for 50 per cent.

Zinc oxide continues very strong with the demand greater than the supply. Production has been increased locally, but orders are still hard to fill. The demand for low-leaded and lead free is strong, but not quite as strong for high-leaded. Prices remain the same.

Barytes continue in heavy demand at same prices, but an ultimate advance is declared inevitable, by local producers. Unusually heavy business by paint manufacturers is reflected strongly in the barytes field. Prices for water-floated barytes remain at $23 to $25 a ton, including barrels; $21.50 to $23.50 in bags, extra charge being made for the bags; all prices f.o.b. mills in carload lots.

Chicago, July 28, 1919.

Marked advances in a few items of heavy chemicals and circus stunts on the part of most items in the line of naval stores have made the Chicago market interesting for the past two weeks. High prices seemingly have no deterrent effect on sales, all dealers reporting business far in excess of normal.

Heavy Chemicals—Caustic soda and soda ash are holding firm at quotations established three weeks ago, solid caustic bringing 3c. to 3½c., and granulated 4c., soda ash 2c. The threatened advance in bleaching powder (calcium hypochlorite) has not occurred, price remaining firm at 2c. with good demand.

Niter cake (sodium bisulphate) shares in the prosperity of sulphuric acid, quantities having been placed under contract by the steel interests at about $4 a ton. Spot sales in small lots are bringing a considerably higher price. Sodium bichromate has advanced from 7½c. on the first of the month to 11½c. today, with apparently the end not yet in sight.

Potassium carbonate is still being quoted by some dealers as high as 22c., though several lots have changed hands at a much lower figure; but 17c. should probably be considered actual price today. Yellow potassium prussiate is another article that has gone up to a surprising degree, sales being effected this week at 65c. against an easy market of 35c. three weeks ago.

Vegetable Oils—Linseed oil struck a record high figure in Chicago about ten days ago of $2.73 in barrels, this figure holding but a short time, however. It is now quoted at $2.48. The very complete tie-up of building operations now in effect here may cause some reduction, as local consumption will be seriously reduced. Other vegetable oils have remained steady, quotations of July 9th letter still holding good.

Flotation Oils, Naval Stores.—There seem to be no limits to the price heights which have been or may be reached in these lines. Turpentine heads the list with plenty of sales being effected at 1.36, and its habit of jumping not less than one cent a day seems to have become confirmed. Rosin is also high, grade WW being quoted at 21.60, F at 17.70, E at 17.45 and B at 16.50, delivered Chicago. Pine tar in barrels brings 35c. to 37c. and pine tar oil 38c to 40c.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JULY 28, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.54 – $0.60
Acetone	lb.	$0.13½ –	.15 –
Acid, acetic, 28 per cent	cwt.	2.75 – 3.00	3.00 – 3.25
Acetic, 56 per cent	cwt.	5.50 – 6.00	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00 – 12.50	13.00 – 13.50
Boric, crystals	lb.	.13 – .13½	.13½ – .14
Boric, powder	lb.	.13 – .13½	.13½ – .14
Hydrochloric, tech. 20 deg	cwt.	1.00 – 1.50	1.75 – 2.50
Hydrofluoric, 52 deg	lb.	.10 –	.11 –
Lactic, 44 per cent. tech	lb.	.11 – .14	.12 – .16
Lactic, 22 per cent. tech	lb.	.05 – .06	.05½ – .07
Molybdic, C. P	lb.	–	6.50 – 7.40
Nitric, 40 deg	lb.	.06 – .06½	.07 – .08½
Nitric, 42 deg	lb.	.07 – .07½	.08 –
Oxalic, crystals	lb.	.24 – .25	.25 – .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 –	.10 –
Picric	lb.	.30 – .40	.50 –
Pyrogallic, resublimed	lb.	–	– 2.30
Sulphuric, 60 deg., tank cars	ton	12.00 – 14.00	–
Sulphuric, 60 deg., drums	ton	17.00 –	22.00 –
Sulphuric, 60 deg., carboys	ton	20.00 –	25.00 –
Sulphuric, 66 deg., tank cars	ton	16.00 – 18.00	23.00 –
Sulphuric, 66 deg., drums	ton	20.00 – 21.00	25.00 – 26.00
Sulphuric, 66 deg., carboys	ton	25.00 –	30.00 – 40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	22.00 –	27.00 –
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 –	32.00 –
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 –	35.00 –
Tannic, U. S. P.	lb.	–	1.30 – 1.40
Tannic (tech.)	lb.	–	.42 – .55
Tartaric, crystals	lb.	–	.84 – .86
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl	gal.	4.00 –	4.85 –
Alcohol, Methyl	gal.	1.20 –	1.23 –
Alum, ammonia lump	lb.	.03½ – .04½	.04½ – .04¾
Alum, potash lump	lb.	.08 – .09	.08½ – .09½
Alum, chrome lump	lb.	.15 – .16 —	.18 – .20
Aluminum sulphate, commercial	lb.	.01¾ – .02	.02¼ – .02½
Aluminium sulphate, iron free	lb.	.02¾ – .03	.03¼ – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 –	.09 –
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	–	.30 – .35
Ammonium carbonate, powder	lb.	.13 – .14	.14 – .14½
Ammonium chloride, granular (white salammonia)	lb.	.12½ – .13	.13½ – .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 – .12½	.13 – .13½
Ammonium nitrate	lb.	.10 –	.11 – .12
Ammonium sulphate	lb.	.05 –	.06 –
Amyl acetate	gal.	–	3.65 –
Arsenic, oxide, lumps	lb.	–	.09 – .09½
Arsenic, sulphide, powdered	lb.	–	–
Barium chloride	ton	75.00 – 80.00	85.00 –
Barium dioxide (peroxide)	lb.	.22 –	.24 –
Barium nitrate	lb.	.10 – .10½	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.02½ –	.02½ – .04
Bleaching powder (see calcium hypochlorite)		–	–
Blue Vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	–	.65 – .75
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	–	.04 – .05
Calcium chloride, fused, lump	ton	19.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	1.75 – 1.80	2.00 – 2.50
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 –
Calcium sulphate, precipitated	lb.	–	.09 – .09½
Carbon bisulphide	lb.	.05½ –	.06 –
Carbon tetrachloride, drums	lb.	.11 –	.12 – .14
Carbonyl chloride (phosgene)	lb.	–	.75 –
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 –	.08 –
Cobalt oxide	lb.	–	1.60 – 1.65
Copperas (see iron sulphate		–	–
Copper carbonate, green precipitate	lb.	–	.28 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .08¾	.09 – .09½
Cream of tartar (see potassium bitartrate)			–
Epsom salt (see magnesium sulphate)		–	–
Formaldehyde, 40 per cent	lb.	–	.20 – .21
Glauber's salt (see sodium sulphate)		–	–
Glycerine	lb.	–	.20 – .21
Iodine, resublimed	lb.	–	4.25 –
Iron oxide, red	lb.	–	.06 – .08
Iron sulphate, (copperas)	cwt.	1.00 –	1.20 – 1.50
Lead acetate, normal	lb.		.12½ – .14
Lead arsenate (paste)	lb.	–	.15 – .17
Lead nitrate, crystals	lb.	–	.85 – .86½
Litharge	lb.	–	.09½ – .10½
Lithium Carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	–	.13 – .04½
Magnesium sulphate, U. S. P	100 lb.	2.00 – 2.63	2.75 –
Magnesium sulphate	100 lb.	1.75 –	2.00 –
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.12 –	.15 – .16
Phosgene (see carbonyl chloride)		–	.70 –
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.25 – .28	.30 –
Potassium bitartrate (cream of Tartar)	lb.	–	.55 – .60
Potassium bromide, granular	lb.	–	.49 – .50
Potassium carbonate, U. S. P	lb.	.60 –	.65 –
Potassium carbonate, crude	lb.	.17 –	.20 –
Potassium chlorate, crystals	lb.	.25 –	.27 – .30
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.32 –	.35 – .40
Potassium iodide	lb.	–	3.30 – 3.40
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	–	.55 – .60
Potassium prussiate, red	lb.	–	.75 – .80
Potassium prussiate, yellow	lb.	.30 – .32	.35 – .40
Potassium sulphate	ton	225.00 –	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake	ton	17.00 – 18.00	–
Silver cyanide	oz.	–	1.19 –
Silver nitrate	oz.	–	.60½ –
Soda ash, light	100 lb.	1.85 – 1.90	2.00 –
Soda ash, dense	100 lb.	2.25 –	2.50 –
Sodium acetate	lb.	.06 – .07	.07 –
Sodium bicarbonate	100 lb.	2.35 –	2.75 – 3.00
Sodium bichromate	lb.	.11 – .12	.12 – .13
Sodium bisulphate (nitre cake)	ton	3.00 – 8.00	10.00 –
Sodium bisulphite	cwt.	1.80 – 1.90	2.00 – 2.10
Sodium borate (borax)	lb.	.07½ –	.08 –
Sodium carbonate (sal soda)	100 lb.	1.35 – 1.50	1.50 – 1.75
Sodium chlorate	lb.	.15 –	.16 – .18½
Sodium cyanide	lb.	.30 –	.31 – .34
Sodium fluoride	lb.	.13 –	.14 – .15
Sodium hydroxide (caustic soda)	100 lb.	2.75 –	3.50 –
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.09¾ – .10	.10½ – .13
Sodium peroxide, powdered	lb.	–	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04 – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.43 – .45½
Sodium prussiate, yellow	lb.	.18 – .18½	.19 – .20
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ –	– .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.05 – 1.35	1.50 – 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	–	.05 – .06
Sodium sulphite, crystals	lb.	.03½ –	.04 –
Strontium nitrate, crystals	lb.	.25 –	– .28
Sulphur chloride	lb.	.05½ –	– .06
Sulphur, crude	tonv	35.00 –	37.50 –
Sulphur dioxide, liquid, cylinders	lb.	–	.10 – .12
Sulphur (sublimed), flowers	100 lb.	3.05 –	– 3.60
Sulphur, roll (brimstone)	100 lb.	2.70 –	3.65 –
Tin bichloride (stannous)	lb.	.48 –	.49 – .50
Tin oxide	lb.	–	.60 –
Zinc carbonate, precipitate	lb.	–	.20 –
Zinc chloride, gran	lb.	.12½ –	.13½ – .14
Zinc cyanide	lb.	.49 –	.50 –
Zinc dust	lb.	.09 – .11	.11 – .12
Zinc oxide, dry American	lb.	–	.10 – .11
Zinc sulphate	lb.	.03½ –	.04 –

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	— $1.10
Alpha naphthol, refined	lb.	1.40	— 1.50
Alpha naphthylamine	lb.	.35	— .50
Aniline oil, drums extra	lb.	.25	— .30
Aniline salts	lb.	.28	— .33
Anthracine, 80% in drums (100 lb.)	lb.	.90	— 1.00
Benzaldehyde (f.f.c.)	lb.	1.00	— 1.15
Benzidine, base	lb.	.95	— 1.15
Benzidine, sulphate	lb.	.90	— 1.10
Benzoic acid, U. S. P	lb.	1.00	— 1.10
Benzoate of soda, U. S. P	lb.	.95	— 1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.24	— .28
Benzol, 90%, in drums (100 lb.)	gal.	.23½	— .27
Benzyl chloride, 95-97%, refined	lb.	.35	— .40
Benzyl chloride, tech	lb.	.25	— .35
Beta naphthol benzoate	lb.	3.75	— 4.50
Beta naphthol, sublimed	lb.	.75	— .80
Beta naphthol, tech	lb.	.45	— .55
Beta naphthylamine, sublimed	lb.	2.25	— 2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—
Ortho-cresol, in drums (100 lb.)	lb.	.23	— .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85	— .90
Cresylic acid, 95-97%, dark, in drums	gal.	.80	— .85
Cresylic acid, 50%, first quality, drums	gal.	.60	—
Dichlorbenzol	lb.	.07	— .10
Diethylaniline	lb.	1.50	— 2.25
Dimethylaniline	lb.	.50	— .57
Dinitrobenzol	lb.	.25	— .37
Dinitroclorbenzol	lb.	.25	— .28
Dinitronaphthaline	lb.	.45	— .55
Dinitrophenol	lb.	.30	— .32
Dinitrotoluol	lb.	.38	— .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	— .46
Diphenylamine	lb.	.70	— .75
H-acid	lb.	1.75	— 2.25
Metaphenylenediamine	lb.	1.20	— 1.80
Monochlorbenzol	lb.	.10	— .14
Monoethylaniline	lb.	1.50	— 1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	— .08
Naphthaline, flake	lb.	.06½	— .07½
Naphthaline, balls	lb.	.08½	— .10
Naphthionic acid, crude	lb.	.75	— 1.25
Nitrobenzol	lb.	.13	— .15
Nitro-naphthaline	lb.	.35	— .45
Nitro-toluol	lb.	.17	— .20
Ortho-amidophenol	lb.	4.25	—
Ortho-dichlor-benzol	lb.	.15	— .20
Ortho-nitro-phenol	lb.	.90	— 1.00
Ortho-toluidine	lb.	.30	— .45
Ortho-nitro-toluol	lb.	.27	— .40
Para-amidophenol, base	lb.	2.60	— 3.50
Para-amidophenol, HCl	lb.	2.75	— 3.25
Para-dichlor-benzol	lb.	.06	— .10
Paranitraniline	lb.	1.00	— 1.25
Para-nitro-toluol	lb.	1.35	— 1.50
Paraphenylenediamine	lb.	2.75	— 4.00
Paratoluidine	lb.	1.50	— 1.75
Phthalic anhydride	lb.	1.75	— 2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10	— .13
Pyridin	gal.	2.50	—
Resorcin, technical	lb.	3.50	— 3.75
Resorcin, pure	lb.	6.50	— 7.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.25	— .30
Salicylic acid, U. S. P	lb.	.30	— .35
Salol	lb.	.75	— .80
Solvent naphtha, water white, in drums, 100 gal.	gal.	.20	— .27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.18	— .24
Sulphanilic acid, crude	lb.	.25	— .30

Tolidine	lb.	1.75	—	2.50
Toluidine, mixed	lb.	.45	—	.80
Toluol, in tank cars	gal.	.22	—	.24
Toluol, in drums	gal.	.23	—	.30
Xylidine, drums, 100 gal	lb.	.44	—	.46
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal	gal.	.23	—	.27
Xylol, commercial, in tank cars	gal.	.22	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.44	—	$0.45
Beexwax, refined, yellow	lb.	.48	—	.55
Beeswax, white pure	lb.	.65	—	.68
Carnauba, No. 1	lb.	.90	—	1.00
Carnauba, No. 2, regular	lb.	.75	—	.85
Carnauba, No. 3, North Country	lb.	.60	—	.65
Japan	lb.	.18½	—	.21
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	.....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.06	—	.06½
Paraffine waxes, refined, 118-120 m.p	lb.	.07¾	—	.08¾
Paraffine waxes, refined, 128-130 m.p	lb.	.09	—	.10
Paraffine waxes, refined, 133-135 m.p.	lb.	.11	—	.12
Paraffine waxes, refined, 135-137 m.p	lb.	.12½	—	.....
Stearic acid, single pressed	lb.	.25	—	.27
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.30	—	.32

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$0.78
Pine oil, pure, dest. dist	gal.	.68
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, ref., sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.34
Turpentine, crude, sp. gr., 0.900-0.970	gal	.72
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.27
Pinewood creosote, ref	gal.	.48

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$16.75	—	$17.25
Rosin E-I	280 lb.	17.50	—	18.75
Rosin K-N	280 lb.	21.00	—	22.25
Rosin W. G.-W. W	280 lb.	22.50	—	22.75
Wood rosin, bbl	280 lb.	17.25	—	.....
Spirits of turpentine	gal.	1.25	—	1.27
Wood turpentine, steam dist	gal.	1.19	—	.....
Wood turpentine, dest. dist	gal.	1.10	—	.....
Pine tar pitch, bbl	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	12.75	—	13.50
Retort tar, bbl	280 lb.	13.75	—	14.50
Rosin oil, first run	gal.	.81	—	.91
Rosin oil, second run	gal.	.83	—	.93
Rosin oil, third run	gal.	.85	—	1.07
Rosin oil, fourth run	gal.	.88	—	1.10

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.54	—	$0.55½
Upriver coarse	lb.	.31	—	.33
Upriver caucho ball	lb.	.31	—	.34
Plantation—First latex crepe	lb.	.39½	—	.40½
Ribbed smoked sheets	lb.	.38½	—	.39½
Brown crepe, thin, clean	lb.	.34½	—	.35½
Amber crepe No. 1	lb.	.36½	—	.37

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.19	—	$0.21
Castor oil, AA, in bbls	lb.	.21	—	.23
China wood oil, in bbls	lb.	.22	—	.24
Cocoanut oil, Ceylon grade, in bbls	lb.	.19¾	—	.20
Cocoanut oil, Cochin grade, in bbls	lb.	.21	—	.22
Corn oil, crude, in bbls	lb.	.22	—	.24
Cottonseed oil, crude (f.o.b. mill)	lb.	.22	—	.23
Cottonseed oil, summer yellow	lb.	.27	—	.30
Cottonseed oil, winter yellow	lb.	.28	—	.29
Linseed oil, raw, car lots	gal.	2.22	—	....
Linseed oil, raw, tank cars	gal.	2.15	—	2.17
Linseed oil, boiled, car lots	gal.	2.17	—	2.22
Olive oil, commercial	gal.	2.30	—	2.50
Palm, Lagos	lb.	.17½	—	.18
Palm, bright red	lb.	.17	—	.18
Palm, Niger	lb.	.16½	—	.17
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.26	—	.27
Peanut oil, refined, in bbls	lb.	.29	—	.30
Rapeseed oil, refined in bbls	gal.	1.55	—	1.60
Rapeseed oil, blown, in bbls	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls., N. Y	lb.	.20	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.18	—	.18½

FISH

Winter pressed Menhaden	gal.	$1.25	—	$1.35
Yellow bleached Menhaden	gal.	1.27	—	1.37
White bleached Menhaden	gal.	1.29	—	1.38
Blown Menhaden	gal.	1.35	—	1.40

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00	—	$36.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	30.00	—	40.00
Casein	lb.	.16	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), dometic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Fledspar	ton	11.00	—	15.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	$30.00	—	$35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	30.00	—	40.00
Fuller's earth, imported, powdered	ton	....	—	.....
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	.....	—	.....
Shellac, D. C	lb.	.....	—	.....
Shellac, V. S. O	lb.	.....	—	.....
Shellac, Diamond I	lb.	.....	—	.....
Shellac, orange, fine	lb.	.....	—	.....
Shellac, orange, superfine	lb.	1.10	—	1.15
Shellac, A.C. garnet	lb.	.95	—	.....
Shellac, bleached, bone dry	lb.	1.35	—	.....
Shellac, bleached, fresh ground	lb.	1.05	—	.....
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	55.00	—	60.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	90-100 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in	net ton	80-90 at Chester, Penn.
Silica brick	net ton	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. —	net ton	$220.00	—	.....
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.32	—	$0.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70	—	.....
Ferro-manganese, 70-80% Mn	gross ton	100.00	—	125.00
Spiegeleisen, 16-20% Mn	gross ton	30.00	—	50.00
Ferro-molydenum, per lb. of Mo	lb.	1.85	—	2.00
Ferro-silicon, 50%	gross ton	85.00	—	115.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.40	—	1.60
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Resales and overstocks make above prices approximate.

Ores and Semi-finished Products

Chrome ore, 35-40%, C_2O_3	unit	$0.60	—	
Chrome ore, 48% and over	unit	.80	—	
Coke, foundry, f.o.b. mines	net ton	5.25	—	$5.50
Coke, furnace, f.o.b. mines	net ton	4.50	—	5.00
Petroleum coke, f.o.b. Atlantic seaboard	net ton	16.00	—	16.50
Fluorspar, gravel, f.o.b. mines	net ton	20.00	—	25.00
Manganese ore, 45% Mn and over	unit	.60	—	.65
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over per unit of WO_3	unit	9.00	—	12.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	10.00
Uranium oxide, 96%	lb.	.....	—	.....
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.15	—	.....
Pyrites, foreign, fine	unit	.15	—	.....
Pyrites, domestic, fine	unit	.14	—	.....
Ilmenite, 50% TiO_2	net ton	30.00	—	.....
Rutile, 95% TiO_2	net ton	200.00	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00

Resales and overstocks make above prices approximate.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	15.00
Hollow building tile, At factory, Perth Amboy, N. J. 8x12x12	M.	194.40
Hollow building tile, At factory, Perth Amboy, N. J. 12x12x12	M.	291.60
Yellow pine, 3x4 to 8x8, 20-24 ft. long	M.	40.00
Yellow pine, 3x4 to 8x8, 20-24 ft. long at Chicago	M.	39.50
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis	M.	37.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	60.00
Roofings, tar pitch (in 400-lb. bbl.)	ton	21.00
Roofings, asphalt pitch	ton	34.00
Roofings, asphalt felt	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft		2.00
Roofings, slate-finished shingles, 100 sq.ft		5.00
Linseed oil, raw in barrels	gal.	2.15
Linseed oil, 5 gal. cans	gal.	2.28
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; forgalvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MONTGOMERY—The Alabama-Georgia Syrup Co., Jones St., plans to build a 2-story, 95 x 170-ft. factory on North Court St. Estimated cost, $50,000. Okel & Cooper, Vandiver Bldg., architects.

Arizona

JOHNSON—The Keystone Copper Co., Newton, Kan., will erect a 100-ton mill, using the flotation and concentration process, at its copper mines six miles east of Johnson.

California

ELRIDGE—The State of California is having plans prepared by the State Department of Engineering, Sacramento, for rebuilding the sewage disposal plant at Sonoma State Hospital, to include an Imhoff tank and sprinkling filter. Estimated cost, $20,000.

NORTH BERKELEY (Berkeley P. O.)—The East Bay Water Co., Oakland, plans to build a filtration plant. C. H. Wilhelm, Oakland, engineer. Hazen, Whipple & Fuller, 30 East 42nd St, New York City, N. Y., architects.

SACRAMENTO—The city voted $1,800,000 bonds for the construction of a filtration plant and water system. Noted May 1.

WATERMAN—The State of California is having plans prepared by the State Engineering Department, Sacramento, for the construction of a new sewage disposal system at the Preston School of Industry, to include an Imhoff tank and sprinkler system. Estimated cost, $14,000.

YOUNTVILLE—The State of California is having plans prepared by the State Engineering Department, Sacramento, for the construction of a sewage disposal plant at the Veterans' Home, to include an Imhoff tank and sprinkling filter. Estimated cost, $10,000.

Colorado

GATEWAY—The Carolite Mining Co. plans to build a reduction plant here. Estimated cost, $25,000.

Connecticut

JEWETT CITY—The Ashland Cotton Co. plans to build a 1-story, 150 x 190-ft. mill. Work will be done by day labor. Estimated cost, $65,000.

NEW HAVEN—The State Board of Health, Capitol, Hartford, will erect a laboratory on Huntington St. Estimated cost, $100,000.

Florida

MIAMI—The city plans to build a filtration plant. State Board of Health, Jacksonville, preparing plans.

TAMPA—The city plans to build a filtration plant. State Board of Health, Jacksonville, preparing plans.

Illinois

CHICAGO—The Century Rubber Works, 1346 Rawson St., plans to build a 3-story, 200 x 350-ft. factory on La Salle St. Estimated cost, $200,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Ohio, engineer.

FREEPORT—The Furst-McNess Co. has awarded the contract for the construction of a 5-story, 75 x 160-ft. reinforced-concrete chemical factory, to H. W. Hoist & Co., State Bank Bldg., Rock Island. Estimated cost, $125,000.

Kansas

RUSSELL—The city plans to build a complete sewerage system and disposal plant. Estimated cost, $60,000. Black & Veatch, International Bldg., Kansas City, Mo., engineers.

Maryland

HIGHLANDTOWN (Baltimore P. O.)—The Jones & Lamb Co., Pennsylvania and Fulton Aves., Baltimore, has awarded the contract for remodeling the plant of the Monumental Brewery Co., at 7th and Lombard Sts. into a meat packing plant and oil refinery, to the Consolidated Engineering Co, 243 Calvert Bldg., Baltimore. Estimated cost, $500,000.

Michigan

DETROIT—The C. B. Bohn Foundry Co., Hart Ave., has awarded the contract for the construction of a 1-story, steel, brick and concrete addition to its core room and a 30 x 30 ft. brick and reinforced-concrete gas house with settling tanks, gas and air line tunnels and ducts, to C. H. Reisdorf, 753 Greenwood Ave.

DETROIT—The Fisher Body Corp., Piquette Ave., will soon award the contract for the construction of a 6-story, 156 x 581-ft. paint shop on St. Antoine St. and Piquette Ave. Smith, Hinchman & Grylls, 710 Washington Arcade, engineers.

Massachusetts

MITTINEAGUE—The Strathmore Paper Co plans to build a factory here. Estimated cost, $100,000.

WORCESTER—The Sewer Commission plans to install an Imhoff sewerage purification system. Estimated cost, $250,000. Address M. Gault, commissioner.

Minnesota

MINNEAPOLIS—The Northwestern Distilled Water Co., 627 Bassett Pl., will soon award the contract for the construction of a 1-story, 30 x 50-ft. distilled water factory at North Minneapolis. Estimated cost, $5000.

ST. PAUL—Charles Weinhagen & Co., 480 Jackson St., plans to construct a 4-story, 110 x 230-ft. reinforced-concrete paper factory and office building on 14th St., near Pine St. Estimated cost, $200,000.

Missouri

MACON—The city has awarded the contract for the construction of a sewage disposal plant, to W. McClurken, 3807 Westminster St., St. Louis. Estimated cost, $16,000.

ST. LOUIS—The T. J. Sayman Co., 2117 Franklin Ave., has awarded the contract for the construction of a 1-story, 50 x 154-ft. soap factory at 2131 Franklin Ave., to the Sayman Real Estate & Investing Co., 2117 Franklin Ave. Estimated cost, $10,000.

Nebraska

LINCOLN—The Lincoln Paint & Color Co. plans to construct a 2-story, 40 x 130-ft. factory at 811 M St. Fiske & McGinnis, 533 Bankers' Life Bldg., architects. Estimated cost, $250,000.

New Jersey

IRVINGTON (Newark P. O.)—The Jennings Silver Co., 309 Nye Ave., has awarded the contract for the construction of a 2-story, 40 x 90-ft. factory, to the Standard Building Block Co., 21st St. Estimated cost, $10,000.

JAMESBURG — The Department of Architecture, 142 West State St., Trenton, received lowest bid for the construction of a sewerage system at the State Home for Boys, from G. L. Robinson, 39 East 28th St., New York City, N. Y. Plans include a 54-ft. stone filter bed, sludge bed, etc. Estimated cost, $10,000. Noted July 1.

NEWARK—The Patton Paint Co., Chester Ave., has awarded the contract for the construction of a 2-story, 61 x 121-ft. factory, to C. R. Heddon Co., Prudential Bldg., at $63,465. Noted June 15.

SALEM—The city will soon award the contract for the construction of a filtration plant, including a coagulating basin, chemical house, filter house and all appliances. W. H. Boardman, 426 Walnut St., Philadelphia, engineer.

TRENTON—The Thermoid Rubber Co., Whitehead Rd., plans to build a 3-story, 100 x 270-ft. plant, here. Estimated cost, $150,000. Osborn Engineering Co., 848 Prospect Ave., Cleveland, Ohio, engineer.

New York

COHOES—James E. Gledhill, 541 West 34th St., New York City, has awarded the contract for the construction of a 2-story, 100 x 400-ft. brick and steel wall paper mill, to C. P. Boland Construction Co., 30 4th St., Troy. Estimated cost, $250,000.

KINGS PARK — The State Hospital Commission, Capitol, Albany, will soon award the contract for extending the sewage disposal plant at the State Hospital, here. Estimated cost, $11,800.

LITTLE FALLS—The Barnet Leather Co., 598 East Mill St., plans to build a 3-story addition to its plant. Estimated cost, $35,000. E. L. White, superintendent.

NIAGARA FALLS—The Niagara Falls Gas & Electric Light Co., 306 Niagara Works, Riverway, will soon award the contract for the construction of a new gas plant at Buffalo Ave. and 22nd St. Estimated cost, $200,000. A. H. Merritt, superintendent.

NUNDA—Peck & Pratt, Inc., have purchased a site and will erect a condensed milk plant. Laboratory equipment will be installed in same. Estimated cost, between $35,000 and $50,000.

TROY—The Rensselaer Polytechnic Institute plans to build a 2-story addition to the William Weightman Walker laboratory. Estimated cost, $175,000. Address Palmer C. Ricketts, president.

North Dakota

NEW ROCKFORD—The city plans to install a water softening plant. Estimated cost, $20,000.

Ohio

ASHLAND—The Ashland Tire & Rubber Co. plans to build a 2-story, 75 x 125-ft. rubber plant. Estimated cost, $90,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, engineer.

ASHLAND—The Faultless Rubber Co. plans to build a 3-story, 80 x 160-ft. factory addition here. Estimated cost, $75,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, engineer.

BARNESVILLE—Morris Knowles, engineer, Jones Law Bldg., Pittsburgh, has submitted a report to the borough for the construction of a sewerage system and a disposal plant. Estimated cost, $100,000. People now running campaign to raise the necessary funds.

CLEVELAND — The Atlantic Foundry Co., 7510 Morgan Rd., plans to build a 1-story, 26 x 36-ft. foundry addition. Estimated cost, $5000.

CLEVELAND — The Crescent Brass Manufacturing Co., 8410 Lake Ave., plans to rebuild the 3-story, 80 x 120-ft. factory which was recently destroyed by fire. Estimated cost, $50,000.

COLUMBUS — The Columbus Tire & Rubber Co., Hayden Bldg., has awarded the contract for the construction of a 2-story, 75 x 300-ft. rubber factory on the west bank of the Olentanzy River, to Cummins & Blair Co., Cleveland. Noted June 15.

CLEVELAND — The McElrath Tire & Rubber Co., 620 Union Bldg., plans to construct a 2-story, 60 x 200-ft. factory on East 131st St. Estimated cost, $80,000.

CLEVELAND—Benjamin Moore & Co., 1514 Marquette Ave., plans to build a 4-story, 60 x 100-ft. paint factory on East 71st and Grant Ave. Estimated cost, $60,000.

CLEVELAND—The National Malleable Castings Co., 7706 Platt Ave., plans to build a 3-story, 49 x 62-ft. research laboratory at 10509 Quincy Ave. Estimated cost, $50,000.

MARION — The American Malleable Castings Co. plans to build a 1-story, 60 x 70 and 70 x 75-ft. addition to its foundry here. Estimated cost, $50,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, engineer.

MIDDLETOWN—The American Rolling Mills Co will build an entire new sheet mill and equip same at cost of $3,500,000. Work will be done by day labor.

WARREN—The D. & M. Cord Tire Co., Engineers Bldg., Cleveland, plans to construct a 3-story, 80 x 120-ft. rubber plant. Estimated cost, $75,000.

Oklahoma

IDABEL—The city will receive bids until Aug. 4 for the construction of a complete sewerage system, including main and lateral sewers and a sewage disposal plant. Johnson & Benham, Firestone Bldg., Kansas City, Mo., engineers. Noted Feb. 1.

Oregon

PORTLAND—The Portland Gas & Coke Co., 294 Yamhill St., plans to build a 1-story, 68 x 70-ft. and 32 x 94-ft. factory, on Linnton Rd. Estimated cost, $10,000.

Pennsylvania

LANCASTER—The city has retained Gannett, Seelye & Fleming, engineers, 204 Locust St., Harrisburg, to prepare plans and supervise construction of a sewage disposal plant.

Rhode Island

CUMBERLAND (Manville P. O.)—The city plans to construct a new sewerage system. Estimated cost, $150,000. O. Perry Sarle, 146 Westminster St., Providence, engineer.

South Carolina

BARNWELL—The city plans an election to vote on $50,000 bonds for the construction of a sewerage system, including a septic tank. Tomlinson Engineering Co., 1003 Loan & Exchange Bank Bldg., Columbia, engineer.

LAKE CITY—The city will receive bids about Aug. 20 for the construction of a sewerage system, gravity type septic tank disposal. Estimated cost, $60,000. Tomlinson Engineering Co., 1003 Loan & Exchange Bank Bldg., Columbia, engineer.

Utah

LEHI—The Utah County School Board will receive bids until Aug. 15 for the construction of a 2-story, 127 x 160-ft. high school. A chemical laboratory will be installed. Estimated cost, $100,000. Ware & Treganza, Utah Savings & Trust Bldg., Salt Lake City, engineer.

West Virginia

HUNTINGTON — The Standard Ultramarine Co., 5th Ave. and 25th St., plans to build a 3-story, 80 x 100-ft. laboratory for the manufacture of bluing, on 24th St. Estimated cost, $25,000.

Wisconsin

PESHTIGO—The Peshtigo Pulp & Paper Co. plans to build a 2-story, 70 x 178-ft. pulp and paper factory on Main St. Estimated cost, $55,000. J. A. Kittle, president. L. A. DeGuerre, Grand Rapids, engineer.

TWO RIVERS—Juul & Smith, Imig Bldg., Sheboygan, is preparing plans for a 2-story, 60 x 190-ft. brick and concrete aluminum factory on Main St. Estimated cost, $80,000. Owner's name withheld.

Ontario

BURLINGTON — The city will soon award the contract for the construction of a sanitary sewerage system. Estimated cost, $150,000. Chipman & Power, Mail Bldg., Toronto, engineers.

DUNDAS—A. W. Dreaske, chairman of the Sewer Committee, received bids for the construction of sewage disposal works, including sprinkler system, etc., from Curran & Clomont, Dundas, $152,032; Canadian Engineering & Construction Co., Toronto, $216,583; Connolly-Agnew Co., Toronto, $228,222. Noted June 15.

FORD CITY—The Imperial Oil Co., 156 Church St., Toronto, has awarded the contract for the construction of a refinery to the Wescott Contracting Co., Windsor. Estimated cost, $100,000.

TORONTO—The city plans to build a pumping station and filtration plant at Victoria Park. Estimated cost, $2,000,000. R. C. Harris, City Hall, engineer.

TORONTO—The city plans to build an experimental activated sludge unit. Estimated cost, $50,000. R. C. Harris, City Hall, engineer.

TORONTO — The Northern Aluminum Co., 158 Sterling Rd., will soon award the contract for the construction of a 10-story, 60 x 280-ft. reinforced concrete factory for the manufacture of aluminum ware and wire. Estimated cost, $300,000. C. P. Turner, 1005 Lindsay Bldg., Winnipeg, Manitoba, engineer.

Quebec

RED MILL—The Canada Paint Co., 572 William St., Montreal, will receive bids in August for the construction of a 3-story, 40 x 60-ft. factory to replace the one which was recently destroyed by fire. Estimated cost, $42,000.

Coming Meetings and Events

The American Ceramic Society will hold a meeting in Chicago, Sept. 24.

The American Chemical Society will hold its Fall meeting in Philadelphia, Pa., Sept. 2-6 inclusive.

The American Electrochemical Society will hold its Fall meeting in Chicago, Sept. 23-25 inclusive.

The American Foundrymen's Association will hold its 1919 convention in Philadelphia, Sept. 29 to Oct. 4.

The American Gas Association will hold its annual convention and exhibition of gas appliances and apparatus at the Hotel Pennsylvania, New York, October 13 to 18.

The American Institute of Mining and Metallurgical Engineers will hold its Fall meeting in Chicago, Ill., Sept. 22-27.

The American Steel Treaters' Society will hold its first annual convention in Chicago, Ill., Sept. 22-27.

The Fifth National Exposition of Chemical Industries will be held in Chicago, Ill., Sept. 22-27 inclusive.

The Institute of Metals Division of the A. I. M. E. will hold its next meeting in Philadelphia, Pa., Sept. 29 to Oct. 4.

The Institute of Metals will hold its Autumn meeting in Sheffield, England, Sept. 24-25.

The Technical Association of the Pulp and Paper Industry will hold its Fall meeting in Chicago from Sept. 24 to 27.

Industrial Notes

Messrs. T. L. Wheeler and J. C. Woodruff, both of whom held the rank of Major in the Chemical Warfare Service, have associated themselves together for the organization of a general consulting business and chemical engineering research work, investigation of processes, design and managing of chemical plants and the organization of technical staffs for chemical concerns. Special attention will be given to the treatment of animal and vegetable fats and oils, electroplating and the electrolytic refining of metals, corrosion and activation of charcoal. Offices have been established at 280 Madison Ave., New York City.

Lieut.-Commander John L. Murrie, formerly of the New York Edison Co. and Capt. Edward F. McCrossin, formerly of the McCrossin Engineering Co. have been relieved of active duty in the navy and army respectively and have organized the firm of Murrie & Co. with offices at 74 Broadway, New York. Murrie & Co. will conduct a general consulting business and will give special attention to financial reports on gas and coal by-product plants.

The United Filter Corp. has established a sales office at 35 Montgomery St., San Francisco, under the direction of the Western Sales & Engineering Corporation. In addition to this office the company's business on the West coast is also taken care of by Kennard & Pierce of Los Angeles, and the United Iron Works, Spokane, Wash. These offices, together with the older ones in Salt Lake City, Chicago and New York, will provide a complete service in this country.

The New Jersey Concentrating Co., 66 York St., Jersey City, N. J., has established a plant for the electromagnetic concentration of low-grade tungsten ores. Impurities such as tin and copper are removed almost completely with an excellent recovery of the tungsten. The plant includes equipment for crushing, sampling and magnetic separation. A sworn sampler and weigher of Messrs. Ledoux & Co. is always on the premises. Proximity to the waterfront and railroad yards gives excellent facilities for loading and unloading ore. Storage space is provided for customers' use.

The Electric Furnace Co., Alliance, Ohio, announces that it has installed a battery of two Baily electric furnaces at the Capital Brass Works, Detroit, Michigan. These furnaces are of the standard 105-kw. tilting type, with hearth capacities of 1500 lb. each. They will be used for melting yellow brass scrap and borings, in the foundry. The Buick Motor Co., Flint, Mich., has purchased its second Baily furnace for melting phosphor bronze. The furnace is of the tilting type, rated at 1500-lb. hearth capacity and an electrical capacity of 105 kw. It is also announced that the Akron Bronze & Aluminum Co., Akron, Ohio, has installed a 50-kw. rectangular tilting type Baily electric furnace in its jobbing foundry. This furnace has a hearth capacity of 300 to 500 lb. and will be used for a wide variety of compositions. Heats will range from 100 to 500 lb. and will include gun metal, phosphor bronze, red and yellow brass.

The Blaw-Knox Co., Pittsburgh, announces the appointment of Mr. Frank O. Leitzell as engineer-salesman in the sheet and tin mill specialties department. Mr. Leitzell was formerly assistant to the general manager of the H. K. Porter Co., Pittsburgh. This company recently completed and formally presented to the children of its employees a playground at Hoboken. This recreation center is complete in every detail and is intended for the employees themselves as well as their children.

Stocks and Bonds

Closing Bid and Asked Quotations July 30, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am.Ag.Ch....	106	106½	Mat.Al.Wk..	31	36
do.pf......	100¼	....	Ten. C. & C.	15⅛	15¾
Barrett Co...	134½	135½	Un. Dyewood	63	70
do.pf......	78½	81	do.pf......	97	97½
Gen. Chem...	175	190	Va.-Car.Ch...	84¼	87
do.pf......	103	108	do.pf......	113¼	113½
Int.Ag.Ch....	31¼	33½			
do.pf......	85	88			

Bonds

Am. Ag. Ch., 1st cv. 5s, '28..............	97½	100
Am. Ag. Ch., cv. db. 5s, '24..............	106¼	109
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32....	84½	85½
Va.-Car. Ch., 1 mtg. 5s, '23..............	95½	96
Va.-Car. Ch., cv.db. 6s, '24..............	103½	104

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co..	93	93½	P-A Pet & Tr	113	113½
Cal. Pet......	47½	47¾	do. pf.....	195	197½
do. pf......	80½	81	Pierce Oil....	23¼	23½
Col. G. & E..	62½	62¾	Royal Dutch.	94¼	94½
Mex. Pet.....	188	189	Sinclair O&R.	59½	59¾
do. pf......	109	111	Texas Co....	265	267
Ohio Cit. Gas.	56½	57	Tex. Pac. Ld. Tr.........	400	500
do. pf......	...	....	Tidewater Oil	240	245
Ohio Fuel S...	52	54½			
Okla. P. & R.	11	11½			

Bonds

Columbia Gas & Electric, 1 5s, '27......	90	90½
Col. G. & El., std. 1 5s, '27............	90	90½
Pan-Am. Pet. & Tr. 1 6s, '19-'27.........	130	....
Pierce Oil, cv. db. 6s, '24...............	105	106
Pierce Oil, cv. 5% Notes, '20	109	129
Sin. O. & R. 1 ln. 7s, '20, with stk. war...	...	142
Sin. O. & R. 1 ln. 7s, '20 without stk war.	99½	100
Texas Co., db. 6s, '31.....................	103	103½
Union Oil of Cal. 1 5s, '31..............	94½	95
United Fuel Gas 1 mtg. 6s, ser. A., '36...	94½	95½

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	As
Am. St. F....	44½	45	Pitts. Ste. pf.	95	97
Beth. Steel...	96	97	Rep. Iron & Steel......	95½	95¾
do. class B..	97½	98	do. pf.....	104½	105½
do. pf., 8%.	113½	114½	Sloss Sheff. I. & S........	69	70
do. pf., 7%.	102	109	do. pf......	92	95
Central Fdry.	39½	41	Superior Steel	44	45
do. pf......	71	73	do. 1 pf....	105	110
Col. F. & I...	50½	51	Trans. & W. Steel......	66½	68
do. pf.......	...	...	Un. Alloy St.	56½	56¾
Cruc. Steel...	137	137½	U.S.C.I.P.&F.	32½	32¾
do. pf......	100½	101½	do. pf......	69	70
Great No. Ore	47½	47¾	U. S. Steel...	110½	111
Gulf Sta. Steel	66	67½	do. pf.....	116½	117
do. 1 pf.....	94	97	Va. Coal,I&C	65	67
Lack. Steel...	86½	87			
Mid.St.&Ord..	56	56½			
Nova Scotia Steel.......	82	83			

Bonds

Beth. Steel, 1 ext. gtd. S.F. 5s, '26.......	96½	97
Beth. Steel, 1 ln. ref. 5s, Ser. A, '42.....	89	90½
Beth. Steel, P. M. & I. S. F. 5s, '36......	86	86½
Buff & Susq. Iron, 1 S. F. 5s, '32.........	92	100
Buff & Susq. Iron, deb. 5s, '27............	...	....
Cent. Found, 1 mtg. S. F. 6s, '21..........	87	....
Col. F. & I., gn. S. F. 5s, '43............	90½	92
Ill. Steel, db. 4½s, '40..................	84½	86
Ind. Steel, 1 mtg. gtd. 5s, '52............	96	97
Lack. Steel, 1 5s, '23.....................	97	98
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50.	97	98
Mid. St. & Ord., clt. cv. S. F., 5s, '36....	89½	89½
Nat. Tube, 1 mtg. gtd. 5s, '52.............	95	98
Rep. I. & S., S. F. mtg., 5s, '40..........	92½	93½
Tenn. C. & I. R.R. 'gn. 5s, '51............	90	90½
U. S. Steel, S. F. 5s, 63..................	100½	101
Va. C., I. & C., 1 5s. '49.................	85½	85½

Published SEMI-MONTHLY *on the* FIRST *and* FIFTEENTH *of each month*

CHEMICAL
& METALLURGICAL
ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, August 15, 1919 *Number* 4

A Thought on The General Unrest

SPEAKING in London to a group of American technical journalists who were the luncheon guests of Lord NORTHCLIFFE, Mr. W. L. HICHENS, managing director of Cammell Laird & Co., Ltd., pronounced some exceptionally sane views on the subject of employer and employee, production and wages, strikes and lockouts. They recur to mind with peculiar force in view of the epidemic of unrest which has recently manifested itself almost throughout the United States. Admitting that his company would like to maintain or even increase wages and reduce working hours, Mr. HICHENS recognized that this could be done only by increasing production, which, in turn, could be accomplished only by improving mechanical devices and by discontinuing the evil practice of restricting output. But it was in relation to labor strikes and inordinate capital profits that his words rang true when be declared that neither labor nor capital had any right "to hold the community up to ransom and pillage them by means of strong combinations." The expression is worth sober reflection by those who apparently have forgotten that "Industry ought to be at the service of the community as a whole," and that no minor class should be allowed to dictate the terms and conditions under which it will play its part in the national life. We cannot believe that the community as a whole is growing in sympathy with groups of men who, either by extortion or by threats of violence, gain an undue advantage over the balance of their fellows. Reaction must set in sooner or later, and in the long run the part of prudence must be to retain the esteem of the public.

Andrew Carnegie, Steel Manufacturer

ANDREW CARNEGIE, Laird of Skibo, philanthropist and American steel manufacturer, died on August 11 in his eighty-fourth year. Much might be said of his public and private benefactions, setting a new world record, his efforts to promote world peace and his intelligent love of art, but these things are well known. How and why he became the greatest steel maker in the world is particularly worth considering. His very first venture in business gives us one key. He had advanced from bobbin boy to stoker, to bill clerk, to messenger boy and then to telegraph operator, when his employer, Col. THOMAS A. SCOTT, division superintendent of the Pennsylvania Railroad, secured him the opportunity to subscribe for ten shares of Adams Express Co. stock at $60 a share. The Carnegie home was mortgaged for $500 and Colonel SCOTT helped young CARNEGIE on the balance. In the industrial depression of 1893-98, when iron mills had failed right and left, it was said that every bank in Pennsylvania held Carnegie paper. Of all producers the Carnegie Steel Co. was the most successful in financing the change from wrought iron to steel.

Easily ANDREW CARNEGIE'S greatest asset was his ability to judge men, and in this his instinct was unerring. At a dinner in Cleveland Mr. CARNEGIE remarked he would like to have the epitaph: "Here lies a man who knew how to get around him men smarter than himself." The Associated Press in its dispatches left out the word "him" and thus set the newspaper paragraphers gasping. It was a matter not merely of getting smart men but of putting them in precisely the most appropriate job. In any business, therefore, Mr. CARNEGIE would have succeeded, but the steel business presented the finest opportunity.

ANDREW CARNEGIE himself said, "Pioneering doesn't pay"; yet in a measure he was a great pioneer. He knew when it was profitable to adopt the new method or the new device. In SWANK'S "Iron in All Ages" there is a list of first producers of bessemer steel in the United States. Carnegie Bros. & Co., Ltd., stand No. 11 in that list, with their first blow August 25, 1875, two 7-ton converters. Twenty years or so later basic open-hearth steel had been made at many works in the United States, but then the Carnegie Steel Co. adopted the process on a large scale. Quick to seize commercial opportunities, the company secured from Alabama much of the pig iron early used in the process, under freight rates that were neither printed nor fit to print.

As the United States was taking front rank in steel production, foreign producers experienced no difficulty in seeing that the key to the success achieved was tonnage outputs. Of that religion ANDREW CARNEGIE was the high priest. It has been related that Capt. WILLIAM JONES, one of the greatest mill managers of all time, would step into CARNEGIE'S office and with pride lay before him a new tonnage record, to which CARNEGIE: "That's fine! That's fine! Can't you do better next week?" When CARNEGIE remarked to JONES what a relief he felt when New York's sky line faded from view as he sailed abroad JONES rejoined: "And you've no idea what a relief it is to us!"

That the Homestead strike of 1892 carried the low tariff political party into power was generally recognized. It was only the psychological channel through which the event operated that was open to discussion. The fairest judgment seems to be that it was not that the voter regarded the tariff as a failure in producing high wages but that the eyes of the Western voters were opened to the high wages offered and still not acceptable. The real contest was on limitation of output. The Amalgamated Association held out for its tonnage rates when output was increased, whereby improved machinery could not earn what it was entitled to. The American steel industry would not be near where it is to-day if the Amalgamated Association had won that contest, and the total payrolls of the industry would be much less than they are.

In selling steel Mr. CARNEGIE'S ability was directly employed. For operating mills and conducting other operations he picked out men, but for years the sales policy was his own. One of his inventions was the sales arrangement that survives to this day as the contract sometimes opprobriously referred to as the "blanket" or "option" contract. He tied up large consumers with larger tonnages than they thought they would need, assuring them they would be taken care of and the contract would not be enforced to their disadvantage. Price agreements he did not keep, nor did the other parties. He played the game as it was being played in those days, more successfully and more fairly than the others.

As they are recalled in these present times some of ANDREW CARNEGIE'S methods seem different from those employed to-day, but it would be idle to assume that if he were living his business life now he would not be the most modern of the modern.

European Opinion Regarding Mexico

SECOND in importance only to the solution of domestic problems is the settlement of the Government's affairs with Mexico. If press reports are to be accepted, we may believe that the Mexican situation is about to receive official attention in Washington, with the moral backing of the principal nations of Europe. It has been no secret for some time that English sentiment has been strongly in favor of the exercise of a firm and just policy in our relations with Mexico; and if the President returns with the same impressions that other Americans receive abroad, he knows that Europe thinks we have dawdled along in our Mexican policy to the point where patience loses its virtuous qualities and becomes a byword.

On numerous occasions in the capitals of Europe, Americans have been reminded of their obvious duty in Mexico, seeing that the Monroe Doctrine prevents European nations taking a hand in American affairs. Another item tending to influence European opinion against Mexico is the unquestionable pro-German bias shown by our southern neighbor during the war, particularly in its early stages before propaganda for the truth bore fruit. Again, refusal of Mexico's request for membership in the League of Nations may be taken as a foreshadowing of European opinion on Mexico's unsatisfactory relations with other nations.

On the whole, it would seem as though all the signs point toward early settlement in some form of the demoralizing conditions that have existed for almost a decade. Whether by benevolent intervention, as in the case of Cuba, or more forcefully, in a way that Mexicans would understand, we feel that the United States owes it to her citizens and the rest of the civilized world to take steps to end an intolerable and almost farcical condition. Opinion is crystallizing through the National Association for the Protection of American Rights in Mexico, which seeks not only protection of American life and property but believes that it can also render a service to the Mexican people, who undoubtedly suffer from the chaos that has prevailed for so many years. Congressional action is indicated in resolutions recently introduced in the House and Senate relative to American claims for damages filed with the State Department, the status of our relations with Mexico, and the use of military force to protect American life and property in Mexico. With an aroused public opinion calling for official action, we have all the elements necessary for an early settlement.

Labor Research And Scientific Control

AT ITS Atlantic City meeting the American Federation of Labor adopted the following preamble and resolution:

> Whereas scientific research and the technical application of results of research form a fundamental basis upon which the development of our industries, manufacturing, agriculture, mining and others, must rest; and
>
> Whereas the productivity of industry is greatly increased by the technical application of the results of scientific research in physics, chemistry, biology and geology, in engineering and agriculture, and in the related sciences; and the health and well-being not only of the workers but of the whole population as well are dependent upon advances in medicine and sanitation so that the value of scientific advancement to the welfare of the nation is many times greater than the cost of the necessary research; and
>
> Whereas the increased productivity of industry resulting from scientific research is a most potent factor in the ever-increasing struggle of the workers to raise their standards of living, and the importance of this factor must steadily increase, since there is a limit beyond which the average standard of living of the whole population cannot progress by the usual methods of readjustment, which limit can only be raised by research and the utilization of the results of research in industry; and
>
> Whereas there are numerous important and pressing problems of administration and regulation now faced by Federal, State and local governments, the wise solution of which depends upon scientific and technical research; and
>
> Whereas the war has brought home to all the nations engaged in it the overwhelming importance of science and technology to national welfare, whether in war or in peace, and not only is private initiative attempting to organize far-reaching research in these fields on a national scale, but in several countries governmental participation and support of such undertakings are already active; therefore be it
>
> *Resolved*, By the American Federation of Labor in convention assembled, that a broad program of scientific and technical research is of major importance to the national welfare and should be fostered in every way by the Federal Government, and that the activities of the Government itself in such research should be adequately and generously supported in order that the work may be greatly strengthened and extended; and the secretary of the Federation is instructed to transmit copies of this resolution to the President of the United States, to the President pro tempore of the Senate, and to the Speaker of the House of Representatives.

This is an illuminating document, and we wish we could feel sure that the whole Federation were behind it. Without doubt it is a record of the aspirations of some of their earnest and consciencious leaders who have vision ahead of their day and generation. And it was voted through as the official expression of that great body.

The preamble contains certain principles which are more progressive than those which usually emanate from the councils of labor or those of manufacturing associations. We call attention to the statement that the development of our industries is based upon scientific research and its applications, and the merit of increasing the productivity of labor by this scientific control. It points out the "ever-increasing struggle of workers to raise their standard of living"—which is wholly in accord with their right to life, liberty and the pursuit of happiness—and it admits that under the present methods of strike and destruction the laborer does not raise himself very much after all. It holds that those who work with their hands may more effectively come into their own through scientific research. The men who framed this resolution recognize that under such research and control, workers will be called upon to meet the situation by sharper lookout and keener observation; that under the new conditions they will have to do more thinking than now, and they are ready for the new tasks.

This is the big vision, and it opens the door to democracy in industry, which is impossibie when the laborer is interested only in his pay and the employer only in getting the work done. Under real scientific control and operation the men remain men; they cease to become "hands." The administrative head knows the need of variety of work to keep up the thinking capacity, and the greater value of men who can think over those who cannot think. And where men do think about their work and how to improve it, they do so to their own greater joy and well-being.

It is not to be expected that the changelings and unwilling workers and miscellaneous incompetents may be found among these well-favored men who do difficult and skilled work. Some provision will have to be made for the stupid so that the intelligent may be able to do what they can do—and what the stupid cannot. The able men who drew this resolution must have foreseen some reasonable segregation between complete and partial men in industry.

Scientific control in its best sense is impossible unless all parties to it are honest, unless they are men who keep their word, who fulfill their contracts and whose sense of responsibility is such that they recognize their obligations to the public as well as to their immediate associates. The defective employer has been justly held up to scorn and contumely and we hope his day may soon pass. We have no sympathy for him. But it is also fair to say that those members of labor unions who are constantly calling for lower costs of living and at the same time fomenting strikes that increase these costs beyond the meanest tricks of the worst profiteers are not developed enough in intelligence or advanced enough in character to participate in this democracy in industry that should follow true scientific control. They are, to put it in plain words, not good enough.

Here and there already we find an establishment in which everybody strives for progress and each one tries to keep ahead of his job; and it is a joy to visit it! And when we find every man making a companion of his daily task and doing his best with it and where the opportunity is really open to each man to advance to the limit of his capacity, we think we begin to sense the Golden Rule of Industry.

War Department Deserts Chemical Warfare Service

PROPONENTS of the Chemical Warfare Service can appreciate the trials of JOB which led him to aver that "The thing which I greatly feared is come upon me"; for Chemical Warfare Service is to be disbanded, as we feared, and its functions are to be turned over to the tender ministrations of the Engineer Corps. The Army, speaking professionally, is against continuing the Service, just as the Army, professionally, was a close corporation, so far as Reserve Officers were concerned. Heaven alone knows, however, what the Army would have done without either or both of them. It is true that the Chemical Warfare Service probably did not cut a fine military figure, but it brought to bear on the war a knowledge of things unknown to the Army and which will continue to be a closed book if the Service is abandoned as recommended. The Chemical Warfare Service also was short on "military stuff," which is the life of the Army, but in this regard civilians will sympathize with the Reserve Officer who protested against "this military stuff in time of war" when he found it handicapped his operations.

Nevertheless the War Department, with a fine disregard for the future, is pursuing a plan which will practically throw into the discard a vast amount of knowledge, actual and potential, merely because the war is over. It is going counter to the recommendations of officers of high rank who believe thoroughly in the specialized organization of the Chemical Warfare Service, and who know how difficult it will be to recover the ground lost by inaction if the Service is abandoned. General SIBERT testified at a hearing before the Senate Committee on Military Affairs that in his opinion the Chemical Warfare Service could not be taken care of as well by the Corps of Engineers as by a separate bureau. He said he did not think engineer officers detailed for tours of duty on rivers and harbors, on fortifications and with troops, were qualified to handle chemical warfare. Lieutenant-Colonel, formerly Brigadier-General, AMOS A. FRIES told the committee that he had come back on temporary order from General PERSHING to present the need of maintaining the continuance of the Chemical Warfare Service after the war.

We recognize that the Engineer Corps constitute a small although brilliant and able branch of the U. S. Army, but they are not chemists. The matter might as well be vested in the Supreme Court, which also contains brilliant and able men, or even better in the Department of Agriculture, for competent chemists are to be found there. The Engineers cannot organize gas warfare when it is needed, because if anything has been proved by the war it is that it takes special practice among chemists to accomplish special results. We have heard manufacturers say, "Oh, we can hire chemists"—indicating that any man with a diploma could give them what they needed—for many years past until, as in England and France, the chemical side of our industries was neglected, and the Germans got the business. Chemical Warfare Service is a branch of the Army that cannot function save under constant practice.

We have given this matter careful consideration, and it is with neither heat nor emotion that we express our opinion that the War Department is seriously in error in the plan about to be adopted.

Western Chemical and Metallurgical Field

Notes on Metallurgical Activities in British Columbia

AN INVESTIGATION of ore-smelting charges in British Columbia, aimed particularly at the Trail smelters' schedules, has been dragging along for several months. After considerable agitation, a committee of four was appointed and held its first meeting at Nelson on Jan. 21, taking evidence from one mine owner in a closed session, then adjourning to meet later at Trail to discuss with the smelter officials the scope and ways and means of the investigation. Considerable objection has been voiced by mine owners to the present inquiry, and they have largely declined to co-operate with the committee, claiming that its personnel is unrepresentative and its powers so limited that no real benefit can result from its activities. Meantime the smelter management, having reduced smeltermen's wages 25c. per day, notified lead miners that the base rates effective April 15 would be reduced from $8.30 to $7.85 per ton.

The Consolidated Mining & Smelting Co.'s research department has been able to solve satisfactorily the metallurgical treatment of the complex lead-zinc ore from its Sullivan mine, an accomplishment of the utmost importance, making available an enormous tonnage of hitherto undesirable ores. Revision of the ore-dressing and metallurgical treatment in the zinc plant has already been started. On account of the added amount of blister copper to be refined which will result from the Canada Copper Corp.'s concentrates, the electrolytic refinery must also be enlarged to 50 tons daily capacity. A rod mill is also considered as a necessary adjunct in order to market this amount of copper in Canada.

Rapid progress in the new plant of the Canada Copper Corp. has been made. This company owns the Greenwood smelter, containing 8 blast-furnaces and 2 converters with a nominal capacity of 950,000 tons of ore per year. Operations have been spasmodic, however, blowing in for a short campaign whenever sufficient ore had accumulated. Thus but 2,200,000 lb. of copper was recovered in 1918, the plant finally shutting down when its principal ore supply, the Mother Lode mine, was exhausted. Since dismantlement of the smelter would be disastrous to the city of Greenwood and its environs, a citizens' committee has been endeavoring to raise the necessary funds to take over the plant and treat ores from the surrounding regions. The company has offered its plant to the committee at $125,000, a very favorable figure in comparison to its value as a going concern; on the other hand, its sale would relieve the present owners of very considerable charges for taxes and insurance. All operations of the Canada Copper Corp. have therefore been removed to its Copper Mountain deposits, whose development is costing approximately $2,500,000. About 12,000,000 tons of 1¾ per cent ore has been blocked out, and a crushing plant and ore storage bin have been built at the mouth of the main haulage system. A 2000-ton concentrator is being built at Allenby, some 5 miles south of Princeton, and is expected to be in operation during the present summer. Its construction has been seriously delayed by non-completion of the 13-mile railroad connection to the Canadian Pacific. During May the workmen employed by the grading contractor struck for an advance in pay, and work was not resumed for a month. Electricity will be had through a 103-mile extension of the West Kootenay Power & Light Co.'s lines, thus serving a consumer located 180 miles distant from the power house. Smelting and refining will be done at Trail.

Granby followed the lead of smelters in the States and posted notices of reduction of wages, following the drop in copper. Their employees at Grand Forks agreed to work for the Butte scale, effective March 1. However, the wage agreement was quite complicated, providing for a bonus of 50c. a day until wholesale prices of living necessities were reduced, a 10 per cent reduction on purchases made at the company store, and a decrease in charges for board. Employees at Anyox were not anxious to accept a reduction in wages, and during the parleys a fire burned a portion of the smelter building, causing $50,000 damage and a shutdown for a month. Upon reopening, a considerable shortage of labor was experienced, but in time most of the vacancies were filled by returned soldiers. Since April 1, however, wages have been increased twice by the Granby company, and now are at about the same figure as at the beginning of the year.

British Columbia's first by-product coke plant was started at Anyox in June. Coal is furnished by Granby's own mines, near Nanaimo, and the resulting coke is consumed in its copper blast-furnaces. Tar is shipped to Vancouver, where a distillation plant separates the valuable fractions.

Company Reports

Jackling Porphyries.—The accompanying tabulation presents comparative milling data taken from the annual reports of the so-called Jackling Porphyries, viz.: Utah Copper Co., Nevada Consolidated Copper Co., Chino Copper Co. and Ray Consolidated Copper Co. Additional information as to operations and improvements are given below.

Utah Copper Co.—As is well known, this company operates two very large concentrators near Salt Lake City. A comparative statement of its tonnage is as follows:

	Magna	Arthur
Total tons concentrated	6,625,000	5,535,700
Daily treatment	18,151	15,166
Rated capacity	12,000	16,000
Extraction	57.9%	73.4%
Cost per ton, 1918	$0.80	$1.08
Cost per ton, 1917	$0.62	$0.78

Near the end of 1918 the new primary crushing plant at Arthur mill was put into operation. It includes a car dumper and electric haulage system, a very large crusher, a complete conveying system and two additional 72 x 20-in. rolls. This scheme overcomes all difficulties in handling frozen, wet, or very large blocks of ore. Similar work is under way at the Magna plant, which, with additions to the fine grinding plant and concentrating department, will double the rated capacity of the latter and materially increases its low extraction now due in part to serious overcrowding. As a matter of fact, the average recovery of both mills for 1918—65.1 per cent—is nearly a record and is especially noteworthy in comparison with the figure for 1917—61.1 per cent—which established a minimum.

The leaching plant above Magna operated throughout the year, handling little more than a third of its rated daily capacity of 3000 tons, owing to an inadequate precipitation and drying system. The ore treated is oxidized copping averaging 0.67 per cent copper soluble in dilute H_2SO_4. Recovery amounted to 11.1 lb. per ton, of which only 10.6 lb. was precipitated and marketed in the form of cement copper, 48.8 per cent pure. Five pounds of 60 deg. Bé. acid was consumed per lb. of copper recovered. The cost of milling, leaching, precipitating, handling tailings and general expense at the leaching plant averaged $1.06 per ton, or almost exactly 10c. per lb. of copper. Crediting an allowance for copper in stock solutions, and adding smelting and selling charges, Mr. Gemmell estimates the copper from the leaching plant as costing 15.1c. Apparently no charge is made for mining, since this ore overlays the sulphide ore and its mining cost is absorbed by the stripping charge. Supposing, however, that mining actually cost 45c. per ton, the cost of cement copper would be increased from 15.1c. to 19.3c. Apparently, then, the managing director's optimistic statements as to the leaching operations refer only to oxidized ore which is moved for stripping and which requires no further handling before delivery to the mill. This view is corroborated by the fact that the leaching plant was closed Jan. 1, 1919, the first department to experience curtailment.

Chino Copper Co.—Chino's recovery of 63.3 per cent was the lowest in its history, and reverses the record of 69.3 per cent made during the previous year. This is attributed to the necessity of mining ores containing undue percentages of oxidized copper, to a shortage of skilled labor and a failure in water supply. All alterations in the old mill were finished, and the new section 6 was started in February. Section 7 started in partial operation in July, but that portion devoted to treatment of oxidized ore was not operated, due to non-delivery of material. Actual milling costs increased 6 per cent over 1917. It may be noticed that the figure $1.37 for milling cost per ton represents an increase of 33 per cent, but the balance represents the amounts reserved for taxes, which were not included in the earlier figures.

At Ray the extraction has shown a gradual increase for several years, which is the gratifying result of a series of minor improvements. The mill now has a capacity of 10,000 tons per day, the tube mill installation in the fine-grinding department having been put in operation in December, and the equipment of the slime plant expanded.

Nevada Consolidated mill recovery shows a decided drop over the record extraction in 1917, due to causes quite similar to those in effect at Chino. The actual tonnage handled should be increased 193,093 tons, this amount being custom ore received from the Consolidated Coppermines Co. This treatment of 11,650 tons daily is an increase of 20 per cent over pre-war years, and a series of minor alterations has now increased the capacity of mine, mill and smelter to about 13,000 tons per day.

The most important construction at the smelter was the installation of a 600-ton coal pulverizing plant for the reverberatory furnaces, replacing the scarce and expensive fuel oil. Four furnaces operated continuously, smelting 654,650 tons of charge, including about 43,000 tons of oxidized ores.

MILLING STATISTICS, PORPHYRY COPPERS, 1918

	Utah	Chino	Ray	Nevada
Tons ore milled..........	12,160,700	3,836,400	3,411,000	3,999,526
Copper content (per cent.)	1.23	1.63	1.61	1.51
Pounds copper produced..	188,092,405	75,655,641	83,599,160	76,607,062
Extraction (per cent.).....	65.11	63.3	74.9	67.3
Tons concentrates produced	....	278,413	....	....
Copper content (per cent.)	16.1	14.25	18.2	8.33
Milling cost per ton......	$0.93	$1.37	$1.01	$0.93
Total cost copper per pound................	16.33c.	17.18c.	17.19c.	17.98c.
Extraction for 1917 (per cent.).................	61.1	69.3	74.5	73.1

Consolidated Mining & Smelting Co. of Canada, Ltd.—In the managing director's report for the year ended Sept. 30, 1918, attention is called to the fact that since the beginning of the war the company supplied the Imperial Ministry with the following major metals:

Electrolytic Zinc,	22,356 tons	at 12.43c. per lb.
Electrolytic Lead,	39,606 tons	at 7.96c. per lb.
Electrolytic Copper,	6,831 tons	at 29.68c. per lb.

All of these prices were materially below the average Canadian market price. Metallurgically, the smelting plant at Trail is in very good shape, and with a capacity not so far expanded as to flood the Dominion metal markets. The zinc plant especially has been thoroughly reorganized, and very large reductions made in costs. A new process for the complex ores of the Sullivan mine has been worked out by the research department, which is of the utmost importance, making available huge quantities of developed ore. While all the present plant will be utilized, considerable additions will be necessary to install the process on a 2000-ton scale, but when this is done there should be no trouble in producing zinc and lead at a profit on any market that has existed in recent years, provided the cost of labor and supplies falls with the price of these metals. Recently very material reductions in cost at the lead refinery have been effected, demonstrating that for small tonnage plants the Betts process can compare very favorably with the Parkes process. An arrangement has been made to treat the copper concentrates from the new mill of the Canada Copper Corp., which will involve an increase in the copper refinery from its present capacity of 20 tons per day to a minimum of 50 tons. A small rod mill also will be installed in order that this extra production may be marketed in Canada.

A. I. M. E. Plans Trip to Gary

In conjunction with a large technical program dealing with recent developments in iron and steel metallurgy, a trip to Gary has been planned for the Chicago meeting of the Institute. Arrangements are being made to charter a steamer to convey the members and guests across the south end of Lake Michigan, directly to the steel works. A tour will be made through the various departments of the steel plant, and luncheon will be served at Gary. Technical sessions on subjects in ferrous metallurgy will be held on the boat en route.

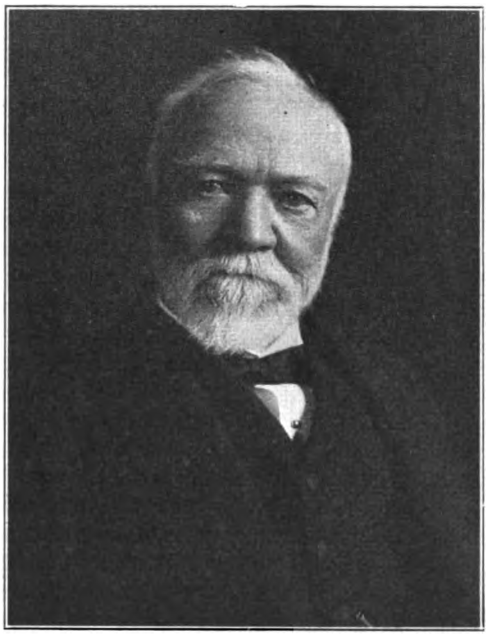
The banquet has been scheduled for the evening of Wednesday, Sept. 24, at the Congress Hotel. By putting this function in the middle of the week it is expected that a maximum attendance can be obtained; members able to come for only a portion of the session can then be present at the banquet, whether they come for the first or latter part of the week.

An elaborate program for the entertainment of the ladies is being prepared, and all members are urged to bring their wives to this meeting.

Andrew Carnegie

ANDREW CARNEGIE died of bronchial pneumonia at Shadow Brook, Lenox, Mass., Aug. 11, at the age of 84. His ancestors for generations back had been weavers. At the time of Andrew's birth, Nov. 25, 1835, his father, William Carnegie, owned a few hand looms. In 1848 the general adoption in Scotland of the steam loom forced William to take his wife and two boys, Andy and Tom, 13 and 6 years old respectively, to America. They made their first home in Barefoot Square, Slabtown, Pa., where the father found employment for himself as weaver and for Andy as a bobbin boy at $1.20 per week wage. The mother sewed for a shoemaker named Phipps. Harry Phipps, the shoemaker's son, was three years younger than Andy. Through lifelong co-operation he and the Carnegie boys were to advance together from poverty to control of the steel industry.

Sixteen years of railroad work developed the big idea from which Mr. Carnegie was to reap his fortune. This was to replace wood construction with iron. On a visit to England in 1868, he learned of the bessemer process and soon had it working in his mills. His success in structural steel manufacture was masterful and he became principal owner of the Homestead and Edgar Thompson Steel Works and other large plants of the firms of Carnegie, Phipps & Co. and Carnegie Bros. & Co. Lake Superior ore and Connellsville coke were incidental developments. In 1899 the Carnegie Steel Co. dominated the steel industry, and in 1901 Mr. Carnegie, after thirty-seven years of activity in the field, retired with a fortune of $460,000,000.



Copyright, Underwood & Underwood.

ANDREW CARNEGIE

Mr. Carnegie's benefactions are in keeping with his wealth and are between 350 and 400 million dollars. Of this amount, 60 million was expended on 2811 free public library buildings; 20 million on colleges; 125 million on the Carnegie Corporation; 30 million on the Carnegie Foundation; 27 million on the Carnegie Institute of Technology; 22 million on the Carnegie Institution of Washington; 4 million on steel workers' pensions, 1½ million on the Engineering Societies Building of New York, etc.

Mr. Carnegie was the author of several books: "An American Four-in-Hand in Britain," 1883; "'Round the World," 1884; "Triumphant Democracy," 1886; "The Gospel of Wealth," 1900; "The Empire of Business," 1902; "The Life of James Watt," 1906; and "Problems of Today," 1909.

In 1888 he married Louise Whitfield. They had one child, Margaret, born in 1897. Miss Carnegie was recently married to Ensign Roswell Miller, U. S. N. The bridegroom was a sophomore in the civil engineering course at Stevens Institute, Hoboken, when war was declared. He planned at the time of the wedding to enter Princeton and complete his studies.

The epitaph to be inscribed on Mr. Carnegie's tombstone at the Sleepy Hollow Cemetery, Tarrytown, N. Y., was written by the steel master and is characteristically descriptive. It reads:

"Here lies a man who knew how to enlist in his service better men than himself."

Associates of Mr. Carnegie have paid elegant tributes to his memory, of which the following are typical:

Chauncey M. Depew—He had a talent beyond any of the constructive manufacturers and merchants, selecting with unerring sagacity the ablest men for the different departments of his industry. Having selected them, he not only gave them great liberties but also large wages according to their success, larger rewards than they could have secured elsewhere. He made many of them phenomenally rich.

Charles M. Schwab—It would be difficult for me to find words to express my love and admiration for Mr. Carnegie. He was my friend, partner and associate for thirty years. He was the greatest man I ever knew and he had a heart so filled with tender sentiment, especially with reference to his associates, as to make him beloved as well as admired by all those who came in business or social contact with him. He possessed the faculty of inspiring others to unusual efforts in a greater measure than any man I ever knew, and he always won by expressions of appreciation rather than criticism. The world has lost a great man and a great benefactor to humanity, and I have lost a greater friend than whom no man ever had.

George W. Perkins, chairman of the finance committee of the Carnegie Foundation — I am deeply grieved to hear of Mr. Carnegie's death. He was a very great American, belonging to that class which after the Civil War was quick to appreciate that we had a united country and a great opportunity. He grasped the new machinery which inventors placed in our hands at that time, and with them threw all his great mental energy into developing our country. When his active business career closed, with the same energy he gave a large percentage of his wealth to movements that he believed would help the people. One of the last talks I had with him was about profit-sharing. He was most enthusiastic in his commendation of the Steel Corporation's profit-sharing plans, and expressed the belief that the principle of profit-sharing was destined to be a great factor in solving the problems between capital and labor.

James B. Clews—The death of Mr. Carnegie removes one of the greatest characters the world has ever known. In these days of labor unrest his career offers a fitting example of what can be accomplished by one commencing in the lowest station of life, when he possesses the necessary qualifications for rising in life and makes the most of his opportunities.

Carnegie was born a weaver, but he threaded together a tapestry of men instead of gilt and fiber.

Army Reorganization Bill Discards Chemical Warfare Service

THE Army reorganization bill, as submitted to Congress, threatens the undermining of most of the technical development of the Army and does not even mention the highly technical Chemical Warfare Service. In a letter accompanying the bill, the Secretary of War suggests that the Chemical Warfare Service can be handled by the Engineer Corps. It is so apparent that this service is so entirely distinct from the work done by the Engineer Corps that chemists are aroused at what they believe to be unreasonable prejudice on the part of the professional element of the Army against a service which they feel contributed the most striking chapter to the record of the war. The General Staff's conception apparently is that a technical man is not fit to be an officer, or at least they intend to make a jack-of-all-trades of him.

Before officers can specialize on gas or any other technical development they must run the gamut of examinations and become thoroughly versed in all matters pertaining to the line of the Army. To make it still harder for the specialist, the bill provides that an officer may serve no more than four years out of any six in one line of duty.

GEN. MARCH AGAINST THE SERVICE

Congress has approved the Chemical Warfare Service to the extent of providing money for its continuance until June 30, 1920, but Gen. March has come out flatly against the service, although he does grant that research in gas should be continued. On the other hand, chemists point out that gas was used in the World War to a comparatively small extent. This was due partly to the lack of ingenuity and initiative on the part of the Germans and also to their lack of raw materials. When the war ended, however, such progress had been made by the Allied Governments as to make possible a fair idea of what might be expected in the use of gas in future wars.

It has developed since the armistice that Germany was so afraid of the possibilities of gas that she herself initiated a propaganda in December, 1917, looking to its being barred during the remainder of the war. In March, 1918, having learned that the Allies were making remarkable strides in gas production, Germany appealed openly for the suspension of gas warfare. That was after Germany learned that the United States alone was actually producing four times as much mustard gas as she herself could produce. As a matter of fact, ninety days after the armistice the United States would have been producing twenty times as much mustard gas as were the Germans, while our production of phosgene and lachrymatory gases were outstripping the German production in almost the same proportion.

OPPOSITION TO GAS WARFARE DIMINISHING

As gas warfare is better understood, the opposition to it is diminishing. Out of all gas casualties among the Allied armies, the death rate was less than 3 per cent. The death rate among casualties resulting from bullets and high explosives often runs as high as 25 per cent. That the Germans were greatly aided by their gas warfare, despite their clumsy use of a weapon that might have been wielded far more effectively, is shown by the fact that gas was responsible for three out of each ten casualties that they caused. An analysis of gas casualties shows that very few of those injured were permanently disabled. There is concrete evidence that it is the most humane way of putting a man out of combat.

Study of chemical warfare leads to prediction by responsible persons that in a possible future war gas will cause 50 per cent or more of all casualties, but by certain changes in gases which even now are being developed the death rate will be cut to one-tenth of that among the casualties caused by high explosives. It is believed that the future will see any battlefield saturated with gas all the time, which will make necessary the continuous use of masks by all within the area.

The highly technical skill necessary in the carrying out of chemical warfare, as well as the need for immense industrial resources, gives the more highly civilized nations a weapon of tremendous efficiency. By the use of lachrymatory or similar gases, it might be possible to dominate a situation entirely without causing loss of life.

The basis of two-thirds of gases used in warfare is in coal-tar derivatives. Most of the remainder are chlorine compounds. An exception is the lachrymatory gas, which has a bromine base. Thus the United States is in an enviable position by having unlimited quantities of the needed raw materials and it is argued that it would be to the nation's advantage to have recourse to chemical warfare in case war became necessary.

The Microscope in War

Captain Howard I. Cole of the laboratory of Arthur D. Little, Inc., at Cambridge, Mass., told lately of the use of the microscope in war. Few persons are aware how large a part this instrument has come to play in chemical analysis, more particularly in the identification of materials.

The most important work was the analysis of defective explosives, primers and other munitions of the Allies, as well as the materials found in captured German shells and duds. By the micrometric measurement of powder grains, etc., it was often possible to report the efficiency of explosives, which is largely dependent upon the size of the particles.

A pocket case 8 in. long will carry as many as 60 little reagent tubes for microscopic work and, as can be readily understood, the chemist can operate with much smaller amounts of material with the microscope than he can without it. Indeed, if the problem has to do, for instance, with the nature of an enemy primer, the very small amount of material under the primer cap usually restricts analysis to this instrument.

Many bodies are determined by their crystalline forms, and both solids and liquids are often recognized by their refractive indices. Many poisons are identified by the same method. There are almost always a considerable number of suicides in battle, some from shooting and others from poisoning. The presence of the suspected poison in the stomach indicates the latter.

Many alloys are examined to discover their content, and the same may be said of fuses. Clothing of all sorts, balloon fabrics, paper cloth, captured sand bags and paper tape for carrying shells were examined to arrive at a sense of conditions in Germany. Food was under constant test to find out whether it had gone bad or not, or was adulterated.

The increased use of the microscope in progressive laboratories as compared with twenty years ago would surely surprise many an old timer.

British Government Aids Dye Trade

The British Board of Trade has set up a central importing agency which will be the sole medium through which dyestuffs can be imported into the United Kingdom. This agency will furthermore buy dyestuffs abroad on a commission of 1 per cent. The American Chamber of Commerce in London reviews the situation as follows:

On Feb. 24, 1919, the importation of all dyestuffs was prohibited except under license. At the same time the government, in accordance with its scheme for assisting the dye-making industry, set up a special Trade and Licensing Committee at Manchester in order to determine the kinds and quantities to be imported and to deal with all importing questions. To get immediate supplies with which to carry on, a general license was issued for all dyestuffs of bona fide American, French or Swiss origin, but this was withdrawn on April 9. Further, to regulate the import of dyestuffs and particularly to prevent the dumping of German materials on the British market, there has now been set up under the direct control of the Trade and Licensing Committee this Central Importing Agency through which all imports of dyestuffs must pass at some stage. This will include imports of German dyestuffs when such trade is allowed by the withdrawal of the trading with the enemy regulations.

Except in the case of German dyes, this Central Importing Agency will now undertake if desired the purchase of dyestuffs abroad on behalf of British consumers. Where it is desired, however, to make purchase direct or through recognized merchants, the goods will merely require to be consigned to the agency for the account of the particular consignee.

The Agency will charge a commission of 1 per cent on the invoice value of the goods for its buying services.

American Institute of Mining and Metallurgical Engineers

Mr. Charles M. Schwab will be a speaker at the banquet of the American Institute of Mining & Metallurgical Engineers to be held in Chicago Sept. 22 to 26 inclusive. Elaborate plans for both the technical and social side of the meeting have been perfected. Engineers who make the trip to Chicago for this meeting are assured of one of the most interesting annual meetings which the Institute has held. In addition to about one hundred and fifty papers which have been prepared for the meeting, trips to the zinc smelting districts, the steel works at Gary and the refineries at Whiting and East Chicago are included. A boat trip on the lake and numerous social events have been arranged for the ladies. The Fifth Annual Exposition of the Chemical Industries will be held in Chicago at the same time and members of the Institute are cordially invited to attend the exposition and become better acquainted with the allied industries.

Importations of German Potash Allowed

Besieged by the farmers on the one hand and the producers on the other, the War Trade Board section of the State Department had a busy time for a month prior to Aug. 7, when it finally decided to throw down the bars and allow the entrance of German potash. The producers now have placed their hope in Congress, and expect to obtain relief in the form of a tariff.

Sewage Disposal Committee

The Division of Chemistry and Chemical Technology of the National Research Council has formed a committee on sewage disposal composed of the following members: Prof. G. C. Whipple, of the Department of Sanitary Engineering, Harvard University, chairman; Major C. G. Hyde, professor of sanitary engineering, University of California; Lt.-Col. Edward Barton, professor of sanitary chemistry, University of Illinois; Lt.-Col. W. D. Bancroft; Prof. E. B. Phelps; Dr. W. W. Garner, physiologist, Bureau of Plant Industry, Department of Agriculture.

The committee will undertake the following projects:

1. To prepare a research survey of the field, with special reference to possible methods of sewage disposal which will recover the valuable oils, fats and fertilizer constituents of the sewage; this survey to include statistical data and a discussion of the economic aspects of the subject as well as the scientific ones.
2. To outline a series of basic research problems necessary to the further extension of our knowledge of the possibilities of recovering and utilizing the valuable constituents of sewage.
3. To ascertain what researches are already in progress in the country in connection with this problem and, if it seems desirable, to prepare a list of sewage experiment stations or similar organizations whose equipment and staffs may possibly be utilized in connection with any project of co-operative research which it seems wise to undertake.
4. To prepare general plans and estimates of cost of establishing a sewage experiment station to study new methods of treating sewage for the recovery of its valuable constituents and to work in close co-operation with investigators now engaged or who in the future may be interested in undertaking physical, chemical or biochemical investigations on various aspects of the problems which present themselves.
5. To investigate particularly the Rice process and the Miles process of sewage treatment and to make recommendations to the Division as to what action, if any, the Council might take with reference to research or development in connection with one or both of these processes.

British and American Dye and Chemical Traders to Send Commission Into Germany

The Dye and Chemical Trade Group of the American Chamber of Commerce in London is about to send a mission into Germany and Austria to study the commercial situation there as related to the dye and chemical industry. Present problems and future prospects will be studied, particularly with reference to import and export possibilities, methods of payment, necessary precautionary measures, etc. Both importers from America and British distributing merchants will be represented on this mission, and the information obtained will be put at the disposal of the industries in both countries. The State Department at Washington has been asked to give official recognition to the American delegates on this commission to enable them to proceed where they wish in Germany and Austria, and to accomplish the objects of their mission.

World's Gold Production

The production of gold has been steadily decreasing since 1915, when the highest point was reached. In that year the world's production of gold was $468,724,918, of which the United States produced $101,035,700, South Africa about $188,000,000 and Australia about $50,000,000. In 1918 the world's production was $377,300,000, of which the United States produced $68,493,500, South Africa $176,000,000 and Australia $26,700,000.

Experimental-Retort Tests of Orient Coal*

Description of Experimental Work for Coking Illinois Coal—Investigation on the Influence of Coking Temperature Upon the Quantity and Quality of Coke Produced—Comparison With Results Obtained When Using Other Coals

By R. S. McBride† and I. V. Brumbaugh‡

The Bureau of Standards, in connection with two special coke-oven tests, found it desirable to investigate the influence of temperature of coking upon the quality of the coke produced and upon the quantity and quality of gas made from the coal[1]. Although several very similar coals were used in the oven tests, the experimental-retort work was limited to coal obtained from the Orient mine of the Chicago, Wilmington & Franklin Coal Co., located at Orient, in the south central part of Franklin County, Illinois. The data obtained from the coking tests with this coal at various temperatures are of such general interest that they are presented here.

A series of five experimental-retort tests was made at various temperatures. The coking was done in a cylindrical retort of cast iron, set up as shown in Fig. 1. This apparatus was made available to the Bureau through the courtesy of the Bethlehem Steel Co., Sparrows Point, Md., which has used this equipment regularly for trying out coals or mixtures of coals intended for its by-product coke ovens. Data of a few similar retort tests on a variety of other coals which have been tested at this plant are presented for comparison.

APPARATUS AND METHOD USED

The cylindrical retort, shown in Fig. 1, was enclosed in a refractory-brick setting approximately 3 ft. in each dimension. It was heated by a large bunsen-type burner, using coke-oven gas. The sample of coal to be tested was pulverized and dried thoroughly, generally by allowing it to remain over night in an oven at approximately 100 deg. before introduction into the small cast-iron box used to hold the charge. The retort was heated up to a temperature from 60 to 100 deg. C. above the temperature desired for the test in order to allow for the unavoidable rapid cooling that takes place when the lid of the retort is opened for introduction of the charge. Immediately after each charge was placed in the retort an oil soaked rag was thrown in. This rag quickly took fire and exhausted the oxygen in the retort space, thus eliminating the possibility of an explosion as the gases from the coal were generated.

The temperature of the retort was maintained at the desired point according to the indications of thermocouple T_1, the location of which is clearly shown in Fig. 1. Thermocouple T_2 furnished auxiliary temperature readings, but these were not used as the basis for temperature control. After introduction of the charge the lid was quickly closed and mudded up to prevent gas leakage. The gas driven off from the coal was discharged from the retort through the outlet pipe shown in the figure. As soon as the gas from the coal began to appear at a purge cock in this line, this purge cock was closed and the gas allowed to flow into a small storage holder in which the entire volume generated from the charge was collected. During the test period record was taken at intervals of 5 min., showing temperatures of T_1, T_2, the volume of the gas collected in the holder, and the temperature of this gas. When the charge ceased gassing the coke was removed and quenched, and a record made of the barometric pressure and of the temperature and volume of the gas in the holder.

After quenching, the coke was examined thoroughly, a description recorded, and an average sample prepared for analysis. The gas collected in the storage holder was analyzed, the candlepower and specific gravity determined, and the heating value calculated from the analysis. From these data were calculated the B.t.u. in the gas per lb. of coal carbonized, the cubic feet of gas per lb. of coal, and the candle-feet per pound.

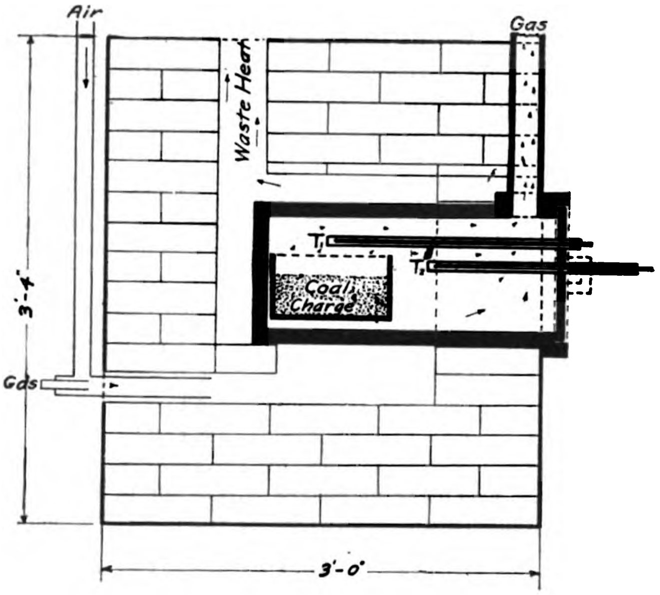


FIG. 1. EXPERIMENTAL RETORT

Arranged for heating by bunsen burner, using coal gas. Inside dimensions of retort: 9½ in. in diameter, 24 in. long; metal 1 in. thick. Inside dimensions of coal box: 9½ in. long, 4⅝ in. wide, 5 in. deep; metal ¼ in. thick. Space between outside of retort and masonry, 2¼ in. Location of thermocouples: T_1, 5⅝ in. from rear and 2 in. from top of retort; T_2, 14 in. from rear and 4 in. from top of retort.

COAL USED

The coal used for four of these tests was that remaining from the sample taken at St. Paul, Minn., when the Bureau tested the coke plant of the Minnesota By-Product Coke Co., using Orient, Ill., coal[2]. For the fifth test there was another smaller sample remaining from another shipment of Oregon coal used by the Bureau in a separate coke-oven test at Dover, Ohio. Table I gives the analysis of these coal samples as used in the retort tests. These analyses agree very closely with those of the carefully prepared samples analyzed by the Bureau of Mines in connection with the plant tests mentioned above. The results of these tests, therefore, can be regarded as typical of the results for the larger shipment. Table II shows the size of the coal as crushed for the retort test.

---

*Published by permission of the Director, Bureau of Standards. This is an advance publication of work reported in Technologic Paper 134 of this Bureau.

†Engineer Chemist, Bureau of Standards.

‡Assistant Gas Engineer, Bureau of Standards.

[1] "The Coking of Illinois Coal in Koppers Type Ovens," by R. S. McBride and W. A. Selvig, CHEMICAL & METALLURGICAL ENGINEERING, Vol. 21, No. 3, Aug. 1, 1919, p. 122.

[2] *Loc. cit.*

RESULTS OBTAINED

The results of the five retort tests are given in Table III. In considering these data it must be borne in mind that only a very limited number of tests could be made because of the small samples and the short time available for the work. One should be very careful, therefore, not to try to draw too many conclusions from these results.

TABLE I—ANALYSIS OF ORIENT COAL AS USED IN EXPERIMENTAL-RETORT TESTS (DRY BASIS)

	Sample from	
	St. Paul, Minn.	Dover, Ohio
Volatile matter	37.8%	38.0%
Fixed carbon	52.3%	53.4%
Ash	9.9%	8.6%
Sulphur	0.87%	1.47%
Phosphorus	0.007%	0.002%
Total carbon	73.0%	76.3%
Hydrogen	5.1%	5.3%
Oxygen	9.9%	8.5%
Ratio: Hydrogen-oxygen	51.6%	62.6%
B.t.u. per lb. (dry)	12,800	13,000
B.t.u. per lb. (dry and ash-free)	14,200	14,200

TABLE II—SIZES OF CRUSHED COAL AS USED IN EXPERIMENTAL-RETORT TEST

Mesh	Percentage Through Sieve
8	99.7
10	89.5
20	50.8
30	36.7
40	30.3
60	19.3
80	13.3
100	11.0

Test No. 1 was made as nearly as possible to duplicate the usual temperature conditions of testing followed by the Bethlehem Steel Co., so that a basis for comparison of this coal with others would be available. In this particular test the gas for heating the retort was cut off completely 40 min. after the introduction of the charge. The data from this test are the only ones which can be compared with the results given in Table IV for other coals. The coke from this sample was fairly good, and the charge was thoroughly coked, showing considerable contraction in the sample box. The pieces were the medium size with no evidence of sponge and only a small amount of fine pebbly material on top of the coke. The coke had very small and regular cell structure, but was soft, shattering rather easily, with a tendency for longitudinal fracture, but no distant cross-fracture. It was light in weight and of a dark silver color.

Test No. 2 was made at as nearly as possible constant vapor temperature (T_1) of 775 deg. C. This was approximately the average temperature of the vapor above the coal as recorded in the test of the coke plant of the Minnesota By-Product Coke Co., St. Paul, Minn., when the coking time was approximately 19 hr., but it is probable that for the same temperature of retort as of oven the vapor temperature in the retort would be higher than the corresponding vapor temperature in the oven. The coke results obtained in this case should probably, therefore, be more nearly comparable with the results of special oven tests made at St. Paul when coking time was approximately 25 hr. The coke from this test was fair, contracted in the box and broke up into large pieces with no sponge and only a small amount of fine material for about $\frac{1}{8}$ in. on the upper surface of the mass. It had small and slightly irregular cell structure; but as a whole the coke was clean, soft, and somewhat tougher than in test No. 1, with longitudinal fracture but no cross-fracture. It was slightly heavier than the material from test No. 1 and of dark color.

TABLE III—EXPERIMENTAL-RETORT TESTS OF ORIENT COAL

Test number	1	2	4	3	5
Date	Jan. 14, 1919	Jan. 15, 1919	Jan. 17, 1919	Jan. 16, 1919	Jan. 18, 1919
Temperature average T_1 (deg. C.)	840	775	700	600	605
Weight of dry coal (lb.)	4.48	4.00	4.00	4.00	3.20
Gas generated (cu.ft. at 30 in. 60 deg. F.)	26.3	18.5	13.6	8.5	7.8
Gas per lb. of dry coal (cu.ft.)	5.87	4.62	3.40	2.12	2.44
Gas per net ton of dry coal (cu.ft.)	11,750	9250	6800	4250	4850
Candlepower of gas	5.4	10.0	12.2	15.7	15.9
Candle-feet of gas per lb. of dry coal	31.7	46.2	41.5	33.3	38.8
Specific gravity of gas	0.465	0.510	0.625	0.660	0.655
Analysis of gas: CO_2	4.7	5.1	8.2	7.2	8.2
O_2	1.0	1.3	1.0	0.8	1.6
Ill.	2.2	3.1	3.8	5.0	5.2
CO	17.3	13.6	11.3	8.1	8.3
CH_4	25.1	30.6	36.6	37.1	39.5
H_4	46.3	44.7	33.6	30.3	26.0
N_2	3.4	1.6	5.5	11.5	11.2
Heating value, calc. from analysis (B.t.u.)	510	570	600	610	625
B.t.u. in gas per lb. of dry coal	3000	2630	2040	1300	1520
Coke formed: Large (lb.) dry	2.99	2.66	2.79	2.72	2.19
Loose material (lb.) dry	0.04	0.06	0.17	0.21	0.19
Total (lb.) dry	3.03	2.72	2.96	2.93	2.38
Coke yield: Large (per cent of dry coal)	67.0	66.5	70.0	68.0	68.5
Loose material (per cent of dry coal)	1.0	1.5	4.0	5.0	6.0
Total (per cent of dry coal)	68.0	68.0	74.0	73.0	74.5
Coke analysis (dry basis):					
Volatile	5.3	7.1	7.1	11.5	14.0
Fixed carbon	80.2	79.1	.....	.....	74.2
Ash	14.5	13.8	.....	.....	11.8
Sulphur	0.78	0.78	.....	.....	1.23
Phosphorus	0.014	0.014	.....	.....	0.004

Test No. 3 was made with the idea of obtaining results at a somewhat lower vapor temperature above the coal than the average prevailing in the St. Paul test, but higher than noted in the other tests made by the Bureau at Dover, Ohio, where the vapor temperature above the coal averaged about 550 deg. C. It was attempted to maintain an average throughout for T_1 of 600 deg. C., and the results correspond very closely to this temperature. Judged by the results of this test, the coal would normally be characterized as only semi-coking at this temperature, for the coke was very poor. There was some contraction in the box and no sponge formed, but there was a very large amount of loose material, that appeared almost uncoked, on top of the larger pieces of coke. The cell structure was small and very irregular. Because there was a very poor cementing action, even the large pieces were soft and easily broken in the hand. The material was fairly heavy, with decided longitudinal fracture and no marked cross-fracture. The color was very dark.

For Test No. 4, in view of the very poor results judged by the character of the coke obtained in test No. 3, it was decided to conduct the test at a somewhat higher temperature. The effort was to maintain T_1 constant at 700 deg. C. throughout this test. Even at this temperature the coal would be characterized as semi-coking, although the coke was superior to that in

TABLE IV—EXPERIMENTAL RETORT TESTS OF OTHER COALS

Data Furnished to Bureau of Standards by the Bethlehem Steel Co. All Tests 4.48 lb. at Approximate T_1 Average of 850 deg C.

Date	May 11, 1918	Sept. 18, 1918	May 16, 1918	May 10, 1918	May 10, 1917	Dec. 6, 1917	May 8, 1917	Feb. 11, 1917
Coal	40% Washington 60% Quemahoning	50% Gauley 50% Pocahontas	Washington	Quemahoning	Morrell, Fayette County, Pa.	Logan County, W. Va.	Mt. Pleasant, Fayette County, Pa.	Tip Top, Fayette County, Pa.
Coal Analysis: Volatile	25.42	28.85	33.02	17.23	31.20	26.08	31.55	30.63
Fixed Carbon	66.58	63.98	58.51	75.45	57.80	45.95	59.86	59.07
Ash	8.00	7.17	8.47	7.32	11.00	27.97	8.59	10.30
Total Carbon	79.63	79.69	77.78	83.15	72.26	59.77	72.45	70.71
Hydrogen	4.72	4.85	5.05	4.48	4.30	3.82	4.41	4.16
Oxygen	6.35	7.05	7.40	3.75	11.01	7.14	13.25	13.63
Ratio: H/O	74.33	68.79	68.24	119.46	39.05	53.50	33.27	30.52
Gas per lb. of coal (cu.ft.)	4.50	4.55	5.10	4.50	5.17	3.49	5.02	4.08
Gas per net ton of coal (cu.ft.)	9,000	9,100	10,200	9,000	10,340	6,980	10,040	8,160
Candlepower of gas	8.0	6.2	8.5	3.7	1.2	10.6	2.6	2.3
Candle-feet of gas per lb.	36.0	28.2	43.3	16.7	6.2	37.0	13.1	9.4
Specific gravity of gas	0.400	0.476	0.440	0.424	0.450	0.466	0.495	0.551
Analysis of gas: CO_2	3.1	4.5	4.1	2.3	5.6	4.4	8.0	10.8
O_2	0.9	0.5	0.7	0.8	0.6	0.6	0.4	0.7
Ill.	2.5	2.0	2.6	1.6	1.4	3.1	1.9	1.6
CO	10.4	12.6	11.7	9.9	15.6	8.6	15.5	14.6
CH_4	29.3	31.5	30.8	27.0	21.5	35.0	24.0	26.5
H_2	52.8	46.8	47.5	57.0	51.1	46.1	48.4	42.7
N_2	1.0	2.1	2.6	1.4	4.2	2.2	1.8	3.1
Heating value calc. from analysis (B.t.u.)	557	556	561	526	465	600	492	490
B.t.u. in gas per lb. of coal	2510	2530	2860	2370	2410	2090	2470	2000
Coke obtained	Extra good* Shatter Test 80%	Good* Shatter Test 66%	Fair* Fingery Sponge Shatter Test 52%	Good	Semi-Coking Coal	Semi-Coking Coal	Non-Coking Coal	Non-Coking Coal

* These results refer to coke from full-size oven tests.

test No. 3. It showed contraction in the sample box, large pieces, and no sponge; but there was a large amount of loose and apparently uncoked material on top of the coke. The small and somewhat irregular cell structure, with soft friable material resulting from a poor bond, corresponds to what would be expected from the results of previous tests. The material was fairly heavy, with typical longitudinal fracture and no cross-fracture, indicating that at this temperature there was a decided tendency to secure blocky coke rather than that of a fingery shape. As in the previous test the material was very dark in color.

Test No. 5 was run with a small sample of coal remaining from the Dover test, in an effort to duplicate the conditions of test No. 3, namely an average for T_1 of 600 deg. Although this coal came from an entirely different shipment from that used at St. Paul, the results were almost exactly the same as from the test No. 3, made at the same temperature.

By comparison of the results for the five tests, the very large influence of temperature of coking upon the quantity and quality of gas is evident. In Fig. 2 is shown graphically the change in quantity of gas per lb. of coal carbonized with changing temperature. In this connection it should be noted that the higher temperature results represent not only a more complete elimination of the volatile material from the coal, but also a decomposition of the heavier volatile material into the gaseous constituents. Naturally, as the vapors leaving the coal are subjected to this greater decomposition at higher temperature, the average heating value of the gas is diminished. This diminution of heating value per cu.ft. is, however, by no means enough to offset the effect of the larger volume, as is shown by the fact that the B.t.u. in the gas per lb. of coal carbonized at 840 deg. is almost double that at 600 deg.

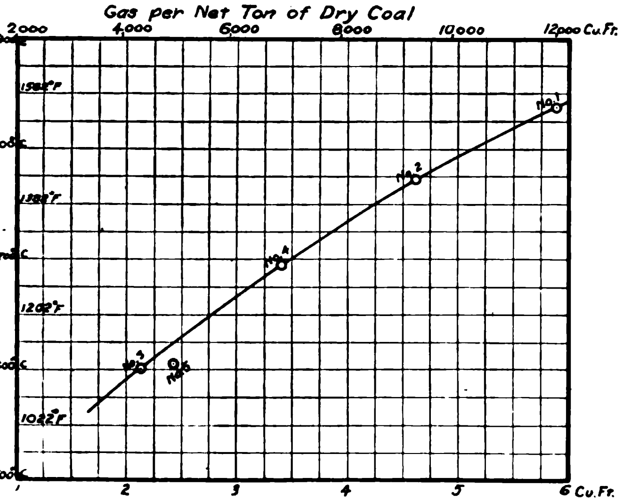


FIG. 2. RELATION OF GAS YIELD TO VAPOR TEMPERATURE T_1 FROM EXPERIMENTAL RETORT TESTS
Test number is indicated beside each result plotted

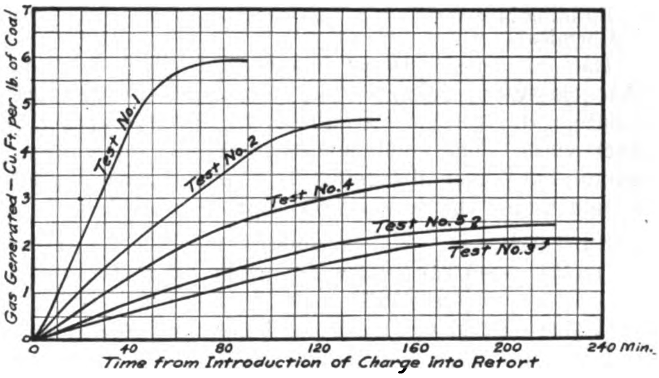


FIG. 3. GAS GENERATED IN EXPERIMENTAL RETORT TESTS

Fig. 3 shows the influence of temperature upon the rate at which the gas is generated and, of course, also the influence of temperature upon the time required for complete gasification of the charge.

INFLUENCE OF TEMPERATURE UPON CHARACTER OF COKE PRODUCED

As would be expected, the amount of volatile matter left in the coke decreases as the temperature of coking increases; and correspondingly with more volatile matter in the coke the yield of coke is higher. However, at the lower temperature the percentage of fine material is much greater and the quality of coke very much inferior. In this connection, however, it should be noted that in none of the coking tests was it practicable to secure temperatures as high as are frequently used in oven practice with coals that are regarded as specially suited to the production of metallurgical coke. If such higher temperatures had been used another influence noted in connection with the St. Paul test would probably have appeared, namely, that at the high temperatures there is great tendency for the coke to be brittle, fingery and small, instead of fairly tough and blocky.

As pointed out above, great care should be exercised in drawing the conclusions from these few tests. However these few conclusions are strong confirmation of the results of the special oven tests made at St. Paul and are, therefore, a very valuable bit of supplementary data, which it is hoped will be of interest to the by-product coke-oven operators in general, but most especially to the operators who use Mid-Continent coals.

SIMILAR RESULTS ON OTHER COALS

For sake of comparison there are included in Table IV data for other coals similar to the data given in Table III for the Bureau's tests of Orient coal. A general comparison of these data is interesting, but no detailed conclusions should be drawn, as comparison of such single tests is apt to be misleading.

Washington, D. C.

Prices of Chemicals During the War

BY FREDERICK E. BREITHUT

Chairman, Chemicals Section, Price Section, War Industries Board

UNDER the direction of Dr. Wesley C. Mitchell, the Price Section of the War Industries Board has made an investigation of prices during the war. The results of this series of studies are embodied in some fifty-seven bulletins which are now in press. The aim of all these studies is to make the price quotations gathered by various Government agencies available to men concerned with problems of business readjustment, and also to provide a permanent record of the great revolution in prices that accompanied the World War.

The commodities selected for price study have been placed in five large groups as follows:

Food
Clothing
Metals
Building Materials
Chemicals

Each of these groups has been further subdivided into classes of commodities industrially or chemically related, and a separate bulletin has been prepared for each class. The commodities placed in the chemicals group have been discussed in fourteen such bulletins issued under the following titles:

Numbeer[1]	Subject	Author
1 (53)	Coal Tar Crudes, Intermediates and Dyes	W. N. Jones and F. W. Cassebeer
2 (54)	Drugs and Pharmaceuticals	W. Lee Lewis and F. W. Cassebeer
3 (50)	Essential Oils, Flavoring and Perfumery Materials	W. B. Meldrum
4 (56)	Explosives	C. L. Fry
5 (48)	Fertilizers	H. L. Trumbull
6 (46)	Heavy Chemicals	H. L. Lewenberg
7 (45)	Mineral Acids	H. L. Lewenberg
8 (47)	Miscellaneous Inorganic Chemicals	W. B. Meldrum
9 (57)	Miscellaneous Organic Chemicals	Arthur Minnick
10 (52)	Natural Dyestuffs and Tanning Chemicals	P. W. Carleton
11 (44)	Paints and Varnishes	Arthur Minnick
12 (55)	Proprietary Preparations	W. Lee Lewis and F. W. Cassebeer
13 (49)	Soaps and Glycerine	H. L. Trumbull
14 (51)	Wood Distillation Products and Naval Stores	P. W. Carleton

To throw as much light as possible upon the course of price fluctuations, each bulletin includes a brief résumé of conditions prevailing in the industry of which it treats, and discussion of data regarding production, imports, exports, stocks, Government purchases and Government control. Special emphasis has been placed upon the factors factors influencing the markets and causing marked variations in prices.

PRICE CHARTS TO SHOW MOVEMENT AWAY FROM PRE-WAR LEVEL

All the bulletins contain graphic representations of the price fluctuations of commodities. These price charts are primarily designed to show the movement of prices away from the pre-war level. They are drawn on a uniform scale and hence are strictly comparable with one another. The average actual prices in the 12 months preceding the outbreak of the war, July, 1913, to June, 1914, inclusive, have been taken as equal to 100, and the actual prices in the whole 72 months from January, 1913, to December, 1918, inclusive, have been converted into relative prices on this basis. If, for example, the selling price of bromine averaged 30c. per lb. during the 12 months preceding the outbreak of the war, and if it rose to 40c. per lb. in December, 1914, the relative price in that month would be 133; if the price rose to 75c. per lb. in September, 1918, the relative price for the latter month would be 250.

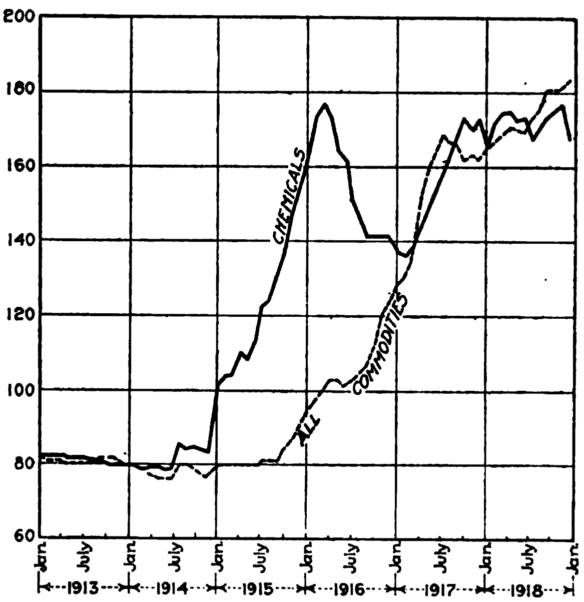


CHART I.

For the benefit of those who wish to gain some idea of the general trend of prices in an industry in addition to the fluctuations in prices of particular commodities, "index numbers" have been calculated. The simple average of the prices of the commodities sold—some by the gram, some by the ton, some by the gallon and some by the liter—would obviously have little value. Therefore, in making index numbers each commodity has been "weighted" by multiplying the monthly prices from 1913 to 1918 by the amount of the commodity produced in 1917, combined with the imports of the commodity during the calendar year 1917. That year was selected as the weighting year because the tables are intended to reflect war-time conditions, and because production data for 1918 were not obtainable for many commodities when the bulletins were being written.

---

[1] The serial number of each bulletin is given in parentheses.

HOW "INDEX NUMBERS" WERE OBTAINED

An enumeration of the successive steps in making these index numbers will show more clearly the significance of the figures. First, for every commodity included in the computation there was made an estimate of the total quantity produced in the United States in 1917, and to this amount the amount imported in the calendar year 1917 was added. The sum represented the "commodity weight." Second, the commodity weight was multiplied by the price of the commodity in each month of the six-year period covered. The product in each case was the "weighted price" for the month. Third, the weighted prices for all the commodities in the class dealt with were added up for each month. This gave the "monthly aggregates" for the class. Fourth, the average monthly aggregate for the 12 months ended June, 1914, was computed. Finally, the average monthly aggregate for the 12 months ended June, 1914, was made equal to 100, and the monthly aggregates for the 72 months changed into relatives on this basis. The results are the index numbers of the class.

The index numbers derived in this way for an industry are strictly comparable with the relative prices for particular commodities. By making use of them one can get a clear idea of average price fluctuations in a given branch of business and can compare fluctuation in one industry with those in others.

In addition to the 50 bulletins devoted to separate classes, the series of price studies includes group bulletins on the prices of foods, metals, clothing, building materials and chemicals. There is also a set of international comparisons of price fluctuations, a special record of Government control over prices during the war, and, finally, a general summary of the whole inquiry, in which the methods employed are set forth more fully and in which the leading results from all the bulletins are drawn together for comparison.

It is the purpose of this paper to summarize the results shown by the 14 class bulletins and the group bulletins dealing with chemicals. To this end two charts have been prepared.

CHEMICALS COMPARED WITH ALL COMMODITIES

Chart I shows the index numbers of chemicals as compared with "all commodities." Comparative features of the two curves are so outstanding that they call for little comment. The "all commodities" curve does not begin its rise until the middle of 1915 and except for a slight depression in the middle of 1916 continues its steady upward course to the neighborhood of 200. The curve for chemicals, on the other hand, begins its rise in the middle of 1914, showing immediate response to the outbreak of the war in Europe. The steep rise in price mounts until reaches almost 200 in the spring of 1916. By this time the United States and the Allies had got into large-scale production, and as a consequence there is a depression, which lasts until the beginning of 1917. The entrance of the United States into the war is immediately followed by a sharp rise in prices of chemicals until the old high level of about 190 is reached. The signing of the armistice finds the price of chemicals hovering in this region. With the signing of the armistice, however, there is a marked contrast between the behavior of the prices of "all commodities" and the behavior of the prices of chemicals. The upward trend of the prices of "all commodities" continues, but the prices of chemicals show instant depression. The tremendous stocks of chemicals on hand and the new facilities and equipment

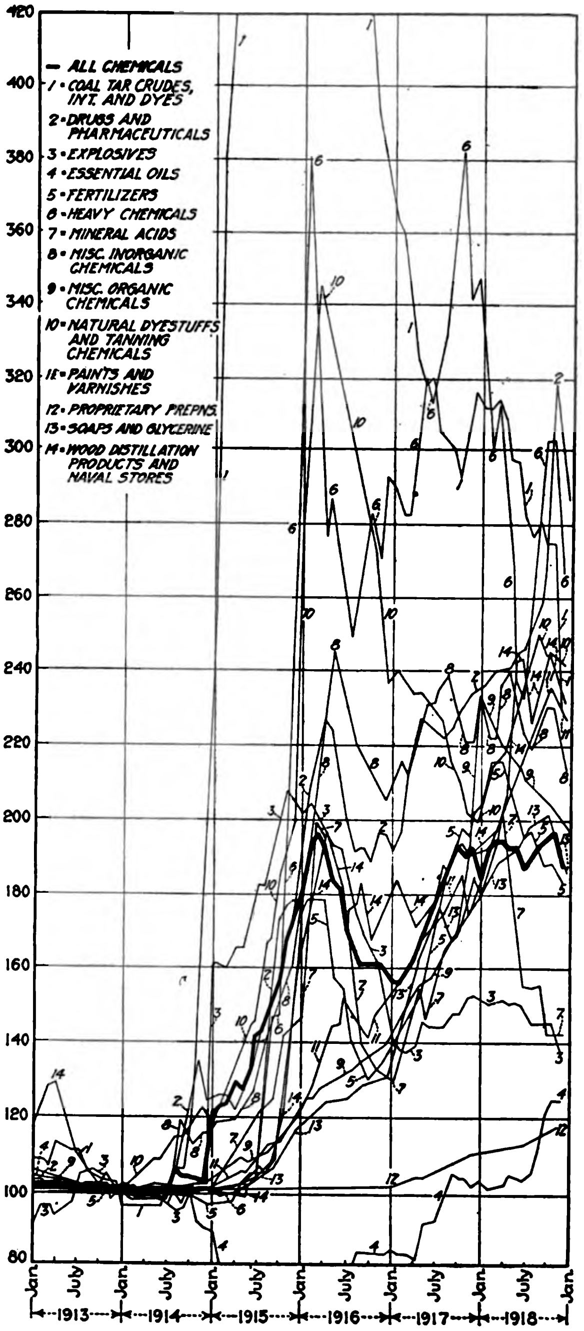


CHART II.

for production—far beyond our needs in normal times—cause this drop.

PRICE FLUCTUATIONS OF CHEMICALS

Chart II presents an analysis of the curve representing the price fluctuations of chemicals. The thin lines represent the index numbers of the 14 classes of chemicals. The heavy line represents the "weighted" index numbers of all chemicals. If we look upon the pre-war base as an elastic band, seeking its normal place at the 100 line, and imagine the play of economic forces as pushing and pulling this band above or below the pre-war level, we have a vivid picture of what actually took place. If we add to this interpretation that the effects of these pushings and pullings on the elastic band shall be proportionate to the "weights" of the industries as represented by the volume of business, we then have a full picture of what this chart attempts to show.

It will be observed that the index numbers of class 1 (coal tar crudes, intermediates and dyes) showed such extreme variation during the period April, 1915, to September, 1916, that they cannot be represented on the scale as drawn in the chart. Therefore the actual figures for this class are given in Table I.

TABLE I—COAL TAR CRUDES, INTERMEDIATES AND DYES

Index Numbers by Months, 1913-1918
Base, Average Price July, 1913, to June, 1914—100

	1913	1914	1915	1916	1917	1918
January	109	95	242	747	364	312
February	109	95	383	732	359	311
March	108	95	417	724	345	314
April	113	95	581	649	325	308
May	112	95	473	649	318	297
June	111	95	596	591	320	297
July	111	103	679	532	305	281
August	106	107	688	478	302	278
September	105	187	697	405	300	280
October	103	215	735	392	293	274
November	103	252	737	376	307	275
December	102	222	758	371	316	229

It is difficult to avoid entering into a detailed discussion of each of the classes, but all these matters are fully covered in individual bulletins, and this paper has for its sole purpose the presentation of a rough, general survey of the whole field. The general economic conditions incident to the war played their several parts. The blockade of German ports, the withdrawal of maritime commerce, the congestion of shipping terminal facilities, the destruction of ships and cargoes, high insurance and shipping rates, the diversion of labor to military ends, Government restrictions and purchases, increased war demands for explosives, drugs and many other chemicals—all found their reflection in the price fluctuations.

SHOULD LEAD TO VALUABLE SUGGESTIONS AS TO FUTURE OF AMERICAN CHEMICAL INDUSTRY

Finally, it may be stated that a careful consideration of these bulletins should lead to valuable suggestions regarding the future of American chemical industry. Wherein are we chemically independent? In what fields are we handicapped? What are the economic principles which should guide our legislators? Will capital take up the development of our chemical industries with the same thoroughness it has shown in other fields? What are the best measures to insure the permanence of an American dye industry? Numberless questions press for solution. To act intelligently we need, first and foremost, the *facts*. These bulletins make available the needed information on prices.

Oil Shales

BY LOUIS SIMPSON

OWING to the continued steady increase in the consumption of hydro-carbon oils and the probable exhaustion of the world's oil fields at a date not very far distant, and because of the probable early exhaustion of certain of the fields as are most conveniently located, it has become necessary to seek for supplies of oil from other sources. No source at present known offers such possibilities as those of the oil-yielding shales and associated deposits containing oil found in nearly all parts of the world.

One quality of such shales has for over 50 years been mined and retorted in Scotland. The retorts used today in that country have been perfected to retort the special quality of shale mined, and take into consideration the very special conditions, industrial, commercial, financial and climatic, existing in Scotland.

As the cost of constructing the retort plant and the cost of operating are vital factors in the commercial operating of such plants, it was natural that engineers and others should devote time to the construction of retort plants that would retort the quality of shale found in countries other than Scotland at less cost, or with a larger yield of oil or a yield of oil of a more desirable quality. This is especially true since the Scotch retort, when erected outside of Scotland, has generally proved to be a failure.

For some reason not apparent, it has been usual for those who have reported or written upon the oil shales question to recommend the use of the Scotch retort and practice and the employment of Scotch engineers, even when they had no experience other than that they had gained in Scotland, and this in the face of the fact that the works erected outside Scotland and which have proved to be failures have chiefly been operated by Scotch officials.

SCOTCH RETORT METHODS NOT APPLICABLE EVERYWHERE

The object of this article is to explain why Scotch retort methods and experience should no longer be considered the last thing in oil shale retorting and why it is necessary that an open mind should be kept when seeking for the best method of retorting a known deposit of shale.

The differences in local conditions are so extreme and are of such character that the blind adoption of any retort should be precluded, even though the retort has been used for years under certain local conditions, as in the case of the use of Scotch retorts by Scotch operators. These differences are found not only in the quality of shale to be retorted, which varies not only as to the extent and character of volatile contents but also as to the extent of nitrogen and carbon contents (the character of the shale itself also varies), as well as in the conditions under which the shale is to be retorted.

It must be evident to every thinking man that a retort may work well when retorting shale that contains, say, 25 gal. of crude oil to the ton and yet may not work satisfactorily when retorting a shale that contains 50, 60 or even more gallons to the ton. Also it is evident that a retort that will operate satisfactorily when retorting shale that contains only 2 to 4 per cent carbon may not be an economic apparatus when retorting shale that contains between 20 and 30 per cent carbon.

It should require no argument to prove that a retort that may be an economic means of recovering the contained nitrogen from shale and that will give a yield of 50 to 75 lb. of sulphate of ammonia to the ton shale might cease to be an economic apparatus when operating on shale that will yield only from 20 to 30 lb. of sulphate of ammonia.

VARYING LOCAL CONDITIONS SHOULD BE CONSIDERED

The quality of shale and of the associated deposits found throughout the world varies within very wide limits, as is above indicated, but the local industrial, commercial, financial and climatic conditions vary as greatly. It is not safe to assume that any new idea, because it is different from those adopted in Scotland by the Scotch oil shale operators, is worthless or that it is not worthy of adoption.

Up to date, there is only one commercial method by which oil is recovered from oil-yielding shale, but there have always been many different applications of the principles that govern the method, and the future will probably see nearly as many different applications as there are different qualities of shales. This method consists of the exposure of shale (placed in a closed chamber to which an exhauster is connected) *to the action of heat,* afterward condensing and working the gases so educed.

Other methods of extraction have been considered, but up to date none has warranted commercial demonstration, but it does not follow that in the future there may not be discovered a method which, by extracting the oil contents from shale that for diverse reasons cannot be retorted, may become of commercial interest.

The retorts now used in Scotland have been in operation about 20 years, and more than one make of retort is being used. It is not unusual to be told in reports that "the Scotch retort has been in use for over 50 years," which, of course, is a gross misstatement.

VARIATIONS IN METHODS OF RETORTING

All the retorts that up to date have been used commercially employ the same principle, the differences being only in the methods of application used. The variations occur in the methods employed:

1. To place the shale within the retort.
2. To remove the spent shale.
3. To apply the required heat.
4. To produce the required heat.
5. To conserve the heat.
6. To remove the educed gases.
7. To condense the educed gases.
8. To wash the gases that resist condensation.

In every commercial proposition the secret of ultimate success will be found in the most economical application of material and appliances suitable for the work, which, perhaps, have been in use in other industries (although unknown to the Scotch operators) or which have recently been discovered.

The question of whether the nitrogen contents of this shale should be fully recovered or otherwise is not argued here. That is a financial and commercial problem requiring an article to itself, but it is well to remember the industrial axioms:

1. That it seldom pays to seek to recover the last percentage.
2. That, with few exceptions, it is not wise to try to save by-products unless the profits received from such recovery equal or exceed the profits that would accrue from the investment in the original business of the money expended in the recovery.

Of the variations in the application of the methods above noted the following may be said:

1. The raw shale may be fed green or dried and may be fed intermittently, that is, the shale may be charged, then educed, and after eduction be discharged, or it may be fed semi-intermittently, as is done in the Scotch retorts, where a batch of shale is dumped into the retort every so many hours, but without any break in the work of eduction, or it may be fed continuously, as in the Del Monte and some other retorts.
2. The spent shale may be removed intermittently or continuously.
3. The heat may be supplied from combustion chambers surrounding the retorts, the heat in such case having to pass through the walls of the retort, or it may be furnished by the admission of preheated fixed gases into the retort.
4. The required heat may be produced by the use of methods too numerous to mention, the best method being that which consumes the least fuel and calls for the fewest repairs.
5. The art of conserving the heat units supplied to the retort has been much neglected in Scotch practice.
6. The removal of the educed gases may be provided for in different ways, but that used by the Scotch is one of the least scientific or desirable, and was only adopted because the method used in Scotland to recover the nitrogen content of the shale necessitated the use of large quantities of steam within the retort. But for this use of steam for another purpose, it would never have been used to assist in the removal of the educed gases.
7. The condensation arrangements, as used in Scotland, are not satisfactory, even under the conditions that exist in Scotland, and are impossible under climatic conditions known to exist in certain districts of the North American continent. The Scotch use atmospheric condensation. The variations experienced in the temperature of the atmosphere in Scotland rarely exceed 60 deg. F., and yet sometimes trouble is experienced. Since temperature variations in parts of this country exceed 120 deg. F. and even 150 deg. F., the use of atmospheric condensers here would be an impossibility. To obtain the best results the work of condensation must progress at the same rate under varying weather conditions.
8. Washing the fixed gases for the recovery of naphtha is a minor question, but one that should not be ignored. In this, again, Scotch practice is not the best, even though Scotch machine builders are producing one of the best mechanical washers known.

It probably is not possible so to design a retort plant that it will contain all the most desirable applications, and the most desirable ones only, but the retort of the future must at least possess a large majority of the most desirable applications, and must also be capable of being quickly constructed, and at a cost very much lower than the present cost of the Scotch retorts.

CONCLUSIONS AS TO MOST DESIRABLE PRACTICE

Of the several variations in the applications noted, the most desirable will certainly be found to be:

1. Continuous feed of dried shale.
2. Continuous removal of the spent shale.
3. Heat supplied through the medium of a preheated gas.
4. A method by which this heat can be supplied without subjecting the retort proper to the high temperatures used in the Scotch retort.
5. Where all heat is conserved to the fullest extent.
6. Where the educed gases are removed as soon as they are educed.
7. Where the educed gases are condensed, under conditions that permit of condensation at a constant and regular speed, and where the resultant oils are delivered fractionated into oils of four or more densities.
8. Where the washer, without long stoppages for cleaning or repairs, will clear the forced gases of all naphtha.

It is also very necessary that the plant should be so laid out that the ground covered is reduced to a minimum. This is necessary not only to reduce the outlay upon pipes of all sorts, but also that the building (which should be of fire-resisting construction) may not be too costly. It is possible so to arrange that a plant with a capacity of 1000 tons of shale in 24 hours, including shale crusher, boiler and power house, but not including storage tanks, will not cover more ground than 2500 sq.ft.

Arrangements should be provided for the economical production of electric power in quantity sufficient to supply the requirements of the plant, including the mines and the transportation system, and also provide the works and the workmen's houses with electric light.

The question of the commercial recovery of the nitrogen in the shale will be considered in another article.

Oil Shale Industry

Owing to the increasing demand for information on oil shale, the Bureau of Mines has recently issued a short paper giving a general discussion of the subject, together with a comprehensive list of references, covering all the important articles published in the United States and Scotland, as well as numerous articles published in other countries.

The paper reviews the history of the oil shale industry in Scotland; presents the status of the industry in the United States; compares conditions in Scotland with those in this country and draws a comparison between the petroleum industry and the oil shale industry, since the former is firmly established in this country and the principal products to be obtained from oil shale are closely related to those obtained from petroleum. Economic features in the development of the industry are also brought out and discussed.

The paper also contains directions for testing shale for oil and ammonia yields, prepared by E. M. Bailey, chief chemist of the Pumpherston Oil Co., the largest producer of shale oil products in Scotland, and describes the methods in use by the United States Geological Survey for assaying shales.

Copies of this paper, the title of which is: "Notes on the Oil Shale Industry, With Particular Reference to the Rocky Mountain District," may be obtained by addressing the Bureau of Mines, Washington, D. C., or the Bureau of Mines Experiment Station, Salt Lake City, Utah.

Senate to Act on Water-Power Bill

There is a movement on foot among the members of the Senate to pass the water-power bill without respect to the difficulties which surround the present discussion concerning the League of Nations and other foreign relations matters and without respect to the inquiries which are now being suggested concerning the high cost of living and the demands of the railroad employees.

It is expected, among Senate leaders, that the water-power bill, which is known as House of Representatives resolution No. 3184, will be reported out by the Senate sub-committee, of which Senator Jones of Washington is the chairman, within a few days. Senator Jones has not yet returned to his work in the Senate from his visit to Seattle, but he is momentarily expected in Washington, and the best information obtainable concerning the water-power bill, according to the Washington report of the McGraw-Hill engineering publications, is that immediately upon his return action will be had upon the bill.

Flotation Monopoly in Spain

IT IS reported that Minerals Separation, Ltd., of London has made a contract with the Sociedad Minera y Metallurgica de Penarroya whereby the latter becomes the sole owner of Minerals Separation flotation patents in Spain. A new company has been organized for the development of the flotation business and it is understood that Minerals Separation has taken an interest in the new company as part compensation for the rights assigned. For the present, it is reported that the Penarroya company will retain the flotation process for its exclusive use, although licenses may be extended to others on terms which have not been announced.

The Penarroya company is said to be practically in control of the lead industry of Spain, owning or controlling every lead smelter in the country. Lead-ore producers are practically at the mercy of the Penarroya company, since ore cannot be shipped out of the country owing to the distance of most of the mines from the sea. As a consequence of this domination the attitude of lead-ore producers is antagonistic to the smelting monopoly. The acquisition of the flotation patents enables the Penarroya company to control the production of lead not only from ore but from concentrates as well, at least for the life of the flotation patents. This latter is of considerable importance when it is realized that the quantity of low-grade ores in Spain is far in excess of that available for direct smelting. In addition to the large deposits of low-grade ore there are enormous dumps in many districts which could be economically treated by the flotation process. The Penarroya company possesses a further advantage in maintaining this monopoly by reason of its association with the banking house of Bauer, which owns the railroads covering the great mineral district tributary to the Penarroya smelters, of which there is one in Linares, and two at Cartagena. This offers superior facilities for the movement of ore, coal and coke, all of which the company owns and produces. The smelter at Linares is owned by the Penarroya company, while the two at Cartagena are controlled by contract. As reported in this journal some months ago, a new smelter is to be erected at Penarroya by Bradley, Bruff & LaBarthe, San Francisco engineers. It is expected that this smelter will be ready for operation early in 1921.

At the fourteenth ordinary general meeting of Minerals Separation, Ltd., held July 3, the chairman, Mr. Francis L. Gibbs, said:

> The large business which lies before us in Spain, which, as you are aware, we are commencing with the assistance of the Sociedad Minera y Metallurgica de Penarroya, has required considerable organization, and for this purpose we are fortunate in having been able again to secure the services of Lieut.-Col. A. C. Howard, D.S.O., M.C., of our engineering staff, who has served with much distinction throughout the war and who has been appointed our resident chief engineer in Spain. With a staff of our engineers, Colonel Howard is actively engaged in bringing to the notice of mine-owners in Spain the great advantage to be gained by the adoption of our methods of concentration. One of the most important matters upon which Colonel Howard and his staff will be engaged during the next few months is the investigation by means of drills of a very large copper concession over which we, in conjunction with the Penarroya company and other powerful groups, have acquired an option. Captain Broadbridge, our chief engineer, examined this concession, and both he and the Penarroya company's engineer report the existence of immense quantities of low-grade copper ore, which can be successfully treated by our processes. Development of this concession is being energetically pushed.

Relation of Microstructure to Phase Changes in Heat-Treated Aluminum Bronzes

Description of the Influence of Heat Treatment on the Microstructure and Other Physical Properties of a Cu-Al Bronze of the Composition 90 Per Cent Copper and 10 Per Cent Aluminum —Adaptability of This Bronze for Bearing and Corrosion-Resistant Metal

By L. R. SEIDELL* and G. J. HORVITZ†

OF THE aluminum bronzes ranging in aluminum content from 9 to 15 per cent, the most important commercially has the composition 90 per cent Cu and 10 per cent Al. This bronze when subjected to heat treatment exhibits interesting variation in microstructure and other physical properties. Previous investigation has demonstrated that with slight variations in the aluminum content above or below this composition wide variations in physical properties of treated and untreated bronze are also obtained.

Our tests, however, were confined to the alloy having the composition 90 per cent Cu and 10 per cent Al, and were carried out as follows:

1. Differential heating and cooling curves were obtained.
2. Specimens were quenched in water at intervals of 100 deg. F. from 800 to 1800 deg. F. and brinelled.
3. Specimens quenched at 1600 deg. F. were drawn at temperatures ranging from 700 to 1500 deg. F. and brinelled.

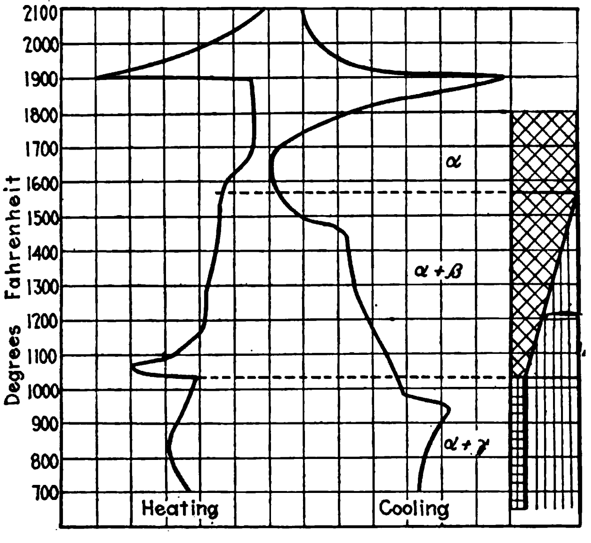


FIG. 1. THERMAL DIFFERENTIAL CURVES AND CONSTITUTIONAL DIAGRAM

4. Microstructure of representative heat-treated specimens was studied.

Thermal Differential Curves

On heating, the first phase change occurs at 1030 deg. F. and is due to transformation of $\alpha + \beta$ to $\alpha + \gamma$, all of which are solid solutions. The next change takes place at 1550 deg. F. This is much less pronounced than the first and represents the point at which absorption of the α into β solid solution is complete. Upon reaching 1895 deg. F. liquation sets in with a consequent large absorption of heat.

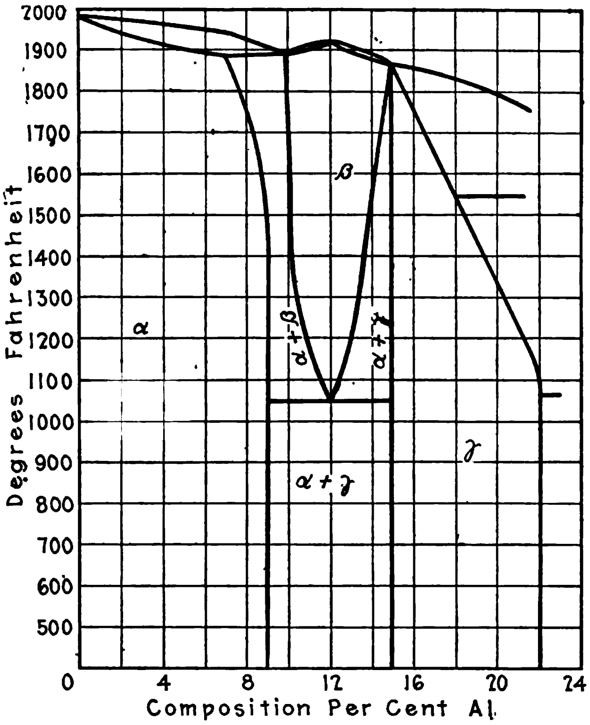


FIG. 2. EQUILIBRIUM DIAGRAM

On cooling, the point at which α begins to separate from β agrees closely with the corresponding point on heating. However, there is a lag of about 50 deg. F. at the β to γ phase change.

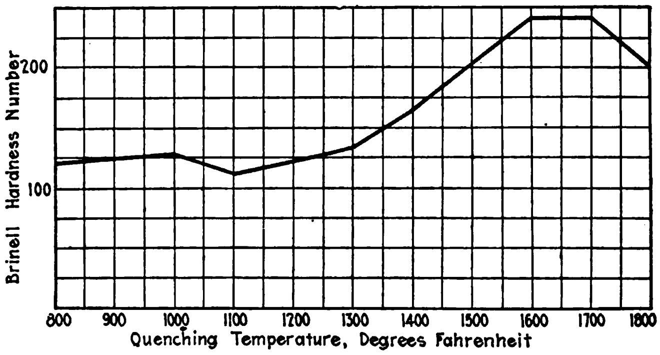


FIG. 3. BRINELL HARDNESS, QUENCHING TEMPERATURE

The constitutional diagram shown beside the heat curves in Fig. 1 represents the nature of the physical constituents present in the different ranges. Below 1030 deg. F. about 17 per cent γ and the remainder α

---

*Managing Director, New York Testing Laboratories.
†Metallurgist, New York Testing Laboratories.

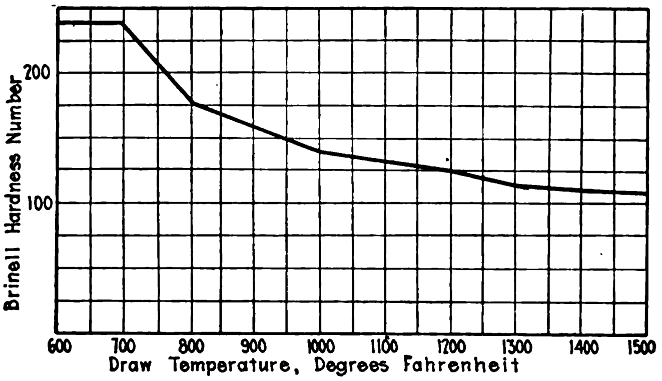
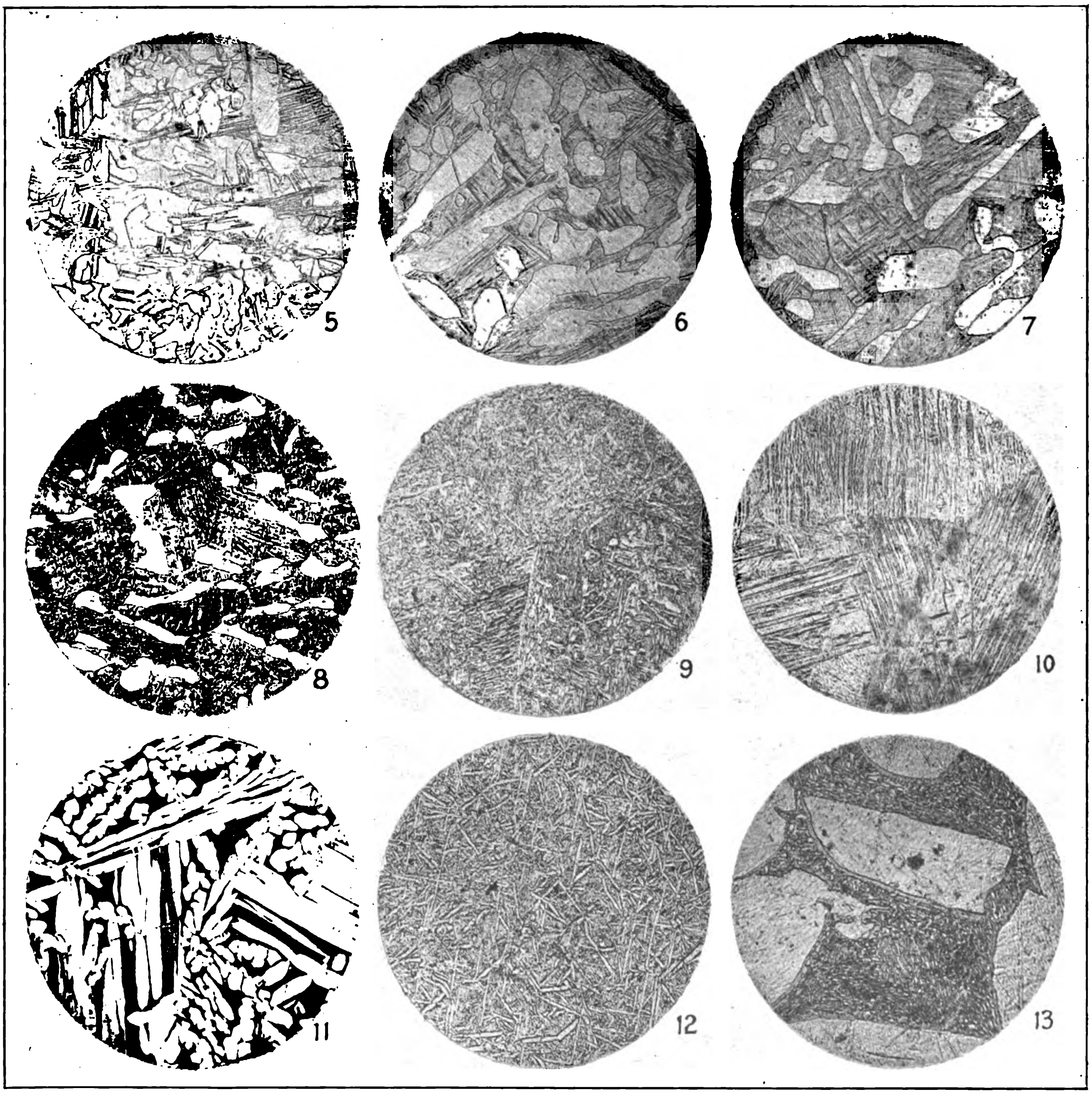


FIG. 4. BRINELL HARDNESS, DRAW CURVE

are present. Above 1030 deg. F. areas formerly γ solid solution are now β. As the temperature rises above this point, α solid solution is absorbed into the β until 1560 deg. F. is reached, at which absorption is complete and structure is 100 per cent β. By quenching from any temperature after holding for a sufficient length of time to insure equilibrium, the nature of the constituents will correspond to those indicated in the diagram for that particular temperature. The phase changes of the thermal curves coincide closely with those of the equilibrium diagram of this particular alloy.

This diagram, first worked out by Curry in 1907, and as generally accepted in the form illustrated in Fig. 2, shows α which is soft and ductile up to 9 per cent



FIGS. 5 TO 13

Fig. 5—Brinell 112; 1100 deg. quench; × 100. Fig. 6—Brinell 133; 1300 deg. quench; × 100. Fig. 7—Brinell 163; 1400 deg. quench; × 100. Fig. 8—Brinell 205; 1500 deg. quench; × 100. Fig. 9—Brinell 240; 1600 deg. quench; × 100. Fig. 10—Brinell 200; 1800 deg. quench; × 100. Fig. 11—Brinell 118; as cast; × 50. Fig. 12—Brinell 140; 1600 deg. quench, 1000 deg. draw; × 100. Fig. 13—Brinell 98; annealed at 1600 deg.; × 200.

and $\alpha + \gamma$ from 9 to 15 per cent aluminum. β ranges from 10 to 15 per cent, with eutectoid point at 12.5 per cent and 1051 deg. F. β has greater tensile strength than either α or γ with correspondingly low ductility.

A series of specimens ½ in. thick were cut from a bar 1¼ in. in diameter. These were quenched in water at temperatures ranging from 800 to 1800 deg. F. Brinell hardness tests were made on each sample and a curve of results plotted (Fig. 3).

Specimen No.	Treatment	Brinell (1000 kg.)
1	As cast	118
2	800	121
3	1000	128
4	1100	112
5	1200	121
6	1300	133
7	1400	163
8	1500	205
9	1600	240
10	1700	240
11	1800	200

The hardness curve follows the phase changes closely and is maximum when the alloy is in the β condition.

To determine the effects of tempering on quenched samples, another series of specimens were water-quenched at 1600 deg. F. and drawn at temperatures from 700 to 1500 deg. F. A curve (Fig. 4) plotted from results of Brinell hardness test showed little drop in hardness up to 700 deg. F. Between 700 and 900 deg., however, maximum drop in hardness occurred. From 1100 to 1500 deg. there was little change.

Specimen No.	Water-Quenched at 1600 Deg. F and Drawn at	Brinell (at 1000 kg.)
1	700	230
2	800	178
3	900	157
4	1000	140
5	1100	133
6	1200	125
7	1300	115
8	1400	110
9	1500	108

The following are indicative of physical properties of this alloy as cast and heat-treated:

Treatment	Elastic Limit Lb. Sq.In.	Ultimate Strength Lb. Sq.In.	Elongation per Cent
As cast	15,000	60,000	28.5
*W. Q. 1470	31,000	98,000	8.0
*W. Q. 1650	55,000	95,000	3.5
*W. Q. 1650 (drawn at 930 deg. F)	49,000	86,000	12.0
*W. Q. 1650 (drawn at 1300 deg. F.)	41,000	80,000	22.7

That heat treatment greatly improves the strength of this bronze is borne out by the above figures.

MICROSTRUCTURE

The structure represented in Fig. 5 is that of a specimen quenched at 1100 deg. F. The solid solutions α and β are present, the α crystals showing considerable twinning. Figures 6, 7 and 8, of specimens quenched at 1300, 1400 and 1500 deg F., respectively, show progressively smaller α crystals as the quenching temperature rises. This is due to absorption of α into β as stated above. Quenching at 1600 deg. F. results in practically all β (Fig. 9), while still higher temperatures merely increase grain size and impart a striated structure to the crystals as indicated in Fig. 10.

A comparison between the structure of the bar as cast and after heat treatment explains in part the cause of considerably greater tensile strength in the case of the treated bronze. The former shows massive primary crystallization of α and γ (Fig. 11) and the latter, quenched at 1600 deg. F. and drawn at 1000 deg. F., a close-grained mixture of needle-shaped α crystals in a matrix of β (Fig. 12). Prolonged annealing at 1600 deg. F. results in α and eutectoid of α and γ (Fig. 13).

The foregoing results suggest the advisability of investigating this alloy for use as a bearing metal. In this connection a structure such as that shown in Fig. 8 may be found desirable. This alloy also may be substituted for steel parts, where special qualities, such as resistance to corrosion, are desired, since in the heat-treated condition its strength compares favorably with that of steel.

BIBLIOGRAPHY

Carpenter and Edward, *Jour.*, Inst. Mech. Eng., 1907.
Curry, *Jour. of Phys. Chem.*, 1907.
Guillet, Les Alliages Métalliques.
Rosenhain & Lantsberry, *Jour.*, Inst. Mech. Eng., 1910.
Andrew, *Jour.*, Inst. of Metals, 1915, Vol. 13, No. 1.
*Portevin and Arnon, *Revue de Métallurgie*, 1916, Vol. 13, No. 2.
Greenwood, *Jour.*, Inst. of Metals, 1918, Vol. 19, No. 1.

Electrical Conductivity and Other Properties of Saturated Solutions of Copper Sulphate in the Presence of Sulphuric Acid

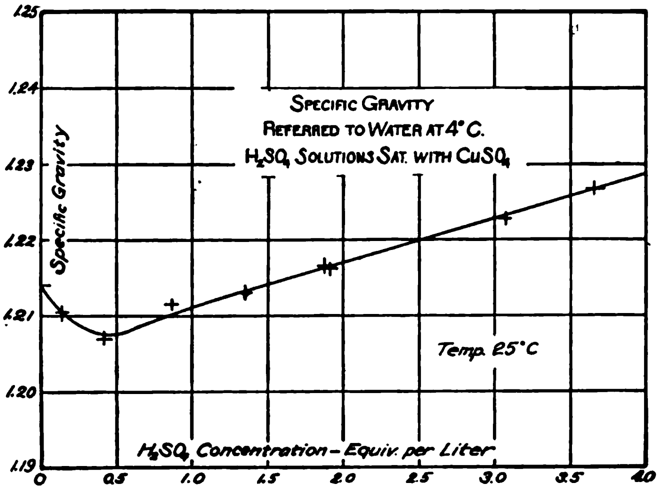
BY H. M. GOODWIN AND W. G. HORSCH

THIS paper gives the specific electrical conductance at 25 deg. C. of solutions saturated with copper sulphate and containing sulphuric acid ranging in concentration from 0.15 equivalent to 3.6 equivalents per liter. The solubility of copper sulphate in the presence of the sulphuric acid and the specific gravity of these solutions are also given. It was intended originally to extend the measurements over a range of temperatures, but circumstances having thus far prevented, it is thought desirable to publish and make available the results already obtained. The calculation of the conductivity of such concentrated mixtures is, in the present state of our knowledge of the degree of ionization of the salt and acid in the presence of each other, practically impossible if accurate results are desired.

The solutions used for these measurements were prepared in wide-mouthed, glass-stoppered bottles of 250 cc. capacity by adding to 200 cc. distilled water an excess of copper sulphate crystals and the desired (approximate) amount of 95 per cent sulphuric acid. Chemically pure sulphuric acid and copper sulphate from a well-known manufacturer were used. The copper sulphate was further purified by two crystallizations. Each bottle was rotated for 2 hr. in a constant temperature bath held to within ± 0.02 deg. of 25 deg. C. At the end of this time the conductivity of the solution was measured without removing the solution from the bottle or the latter from the thermostat. It was then rotated for an hour longer and the conductivity again measured. This procedure was continued until the conductivity became constant, which constancy was taken as the criterion for saturation having been reached.

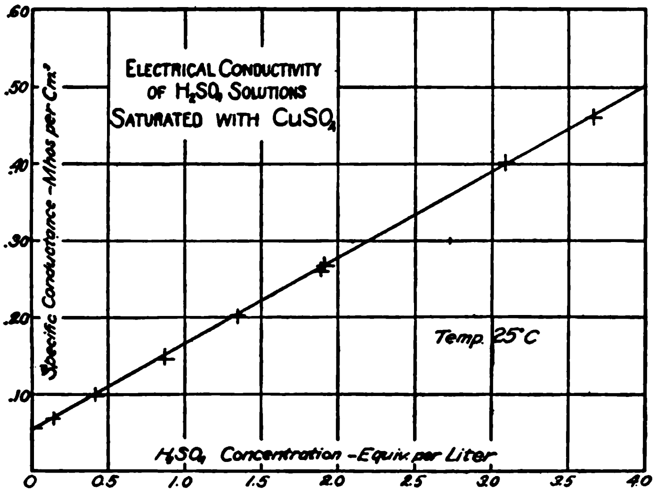
The customary Wheatstone bridge arrangement with a slidewire of the drum type was employed in making the conductivity measurements. A generator furnishing sine wave alternating current at a frequency of 300 cycles per second served as the source of current. The conductivity cell was formed by introducing a pair of plunge electrodes, held rigidly with respect to each other, directly into the wide-mouthed bottle in which the solution was rotated. Each electrode consisted of a cylinder of platinized platinum held about 2 cm. from the lower end of a glass tube of about 1 cm. inside diameter. Below the electrodes the tube was drawn down to 0.5 cm. inside diameter for a distance of 1.5 cm. The bulk of the resistance occurred within these projecting tubes, and the "cell constant" was independent of a reasonable amount of displacement from the normal location of the electrodes in the bottle.

The cell constant was determined by measuring the conductivity of a sulphuric acid solution of maximum conductivity and of a normal potassium chloride solution. The average of the two methods of calibration was used in computing the results, the percentage deviation of the mean cell constant being less than 0.25 per cent. The precision of the final conductivity results is about 0.5 per cent.



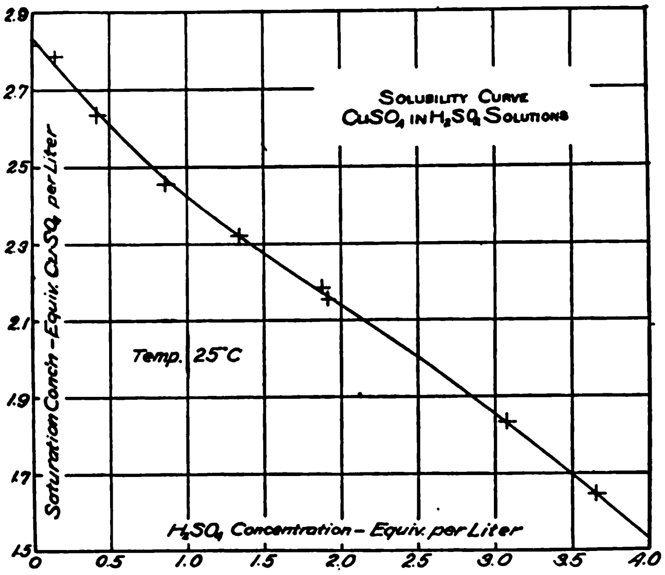
The density of the solutions was determined to ± 0.1 per cent by means of a Mohr-Westphal balance. The results are given as specific gravity referred to water at 4 deg. C.

The copper sulphate content of the solutions was determined by electro-analysis, using, in some cases, a platinum dish as cathode and a rotating platinum anode, and in others a rotating platinum cathode which consisted of a 100 cc. platinum crucible suitably mounted. It was hoped at first that the acid content of the original solution might be obtained by titrating for total acid after the removal of the copper and subtracting the acid equivalent to the amount of copper deposited. Test experiments showed this method to be inaccurate, however, by from 1 to 2 per cent, due largely, probably, to secondary reactions occurring during the electrolysis. The method was therefore abandoned, and the acid titrated with sodium hydroxide solution in the presence of the copper sulphate using methyl orange as indicator. One might expect the end point to be so masked by the blue color of the copper in the solution as to render the method inaccurate, but by sufficiently diluting the solution it was found that perfectly consistent results could be obtained. When acid, the solution appears a deep purple; when alkali it is green; the end point chosen was that at which a trace of pink could be detected in the green solution[1]. The sodium hydroxide solution was standardized by titrating against a standard sulphuric acid solution, which in turn was standardized against anhydrous sodium carbonate.



The results, shown graphically in the plots, are given in the following table:

Temperature, Degrees Centigrade	Concentration H_2SO_4 Gram Equivalents per Liter	Saturation Concentration $CuSO_4$ Gram Equivalents per Liter	Specific Conductance in Mhos.	Density Referred to H_2O
25.00	......	2.818	0.05555	1.2140
25.00	0.1488	2.784	0.06884	1.2105
25.00	0.4208	2.634	0.09845	1.2070
25.00	0.8680	2.457	0.1458	1.2115
25.00	1.345	2.320	0.2023	1.2130
25.01	1.876	2.181	0.2608	1.2165
25.00	1.914	2.153	0.2671	1.2162
25.02	3.077	1.837	0.4005	1.2229
25.01	3.659	1.649	0.4596	1.2267



Conductivity determinations on solutions containing various concentrations of sulphuric acid and copper sulphate and at various temperatures are covered by the following references:

Hollard, *J. de Phys.*, 5, 654 (1906).

Richardson and Taylor, *Am. Electroch. Soc. Tr*, 20, 179 (1911).

Addicks, *Electrochem. & Met. Ind.*, 4, 17 (1906). (Now consolidated with CHEM. & MET. ENG.)

Thompson and Hamilton, *Am. Electroch. Soc. Tr.*, 17, 289 (1910).

For the effect of sulphuric acid on the solubility of sulphates see Engel, *Comptes Rendus*, 104, 507 (1887).

Electrochemical Laboratory,
Massachusetts Institute of Technology,
Cambridge, Mass.

---

[1] To indicate the degree of precision with which this titration can be carried out in a solution containing copper ions, the following results are appended:

Titration of NaOH vs. H_2SO_4, no copper present		Titration of NaOH vs. H_2SO_4 in presence of $CuSO_4$	
1 cc. NaOH =	0.9605 cc. H_2SO_4	1 cc. NaOH =	0.9541 cc. H_2SO_4
	0.9594		0.9574
	0.9572		0.9585
Mean,	0.9590	Mean,	0.9567

The deviation of the two mean results is less than one-quarter of one per cent.

Japanese Porcelains From Chemical Point of View, and How to Improve Them*

EXHAUSTIVE investigations have been made by Yaichiro Kitamura on Japanese porcelains which have been known to possess the following compositions by authorities on ceramics since Hermann A. Seger's reports in the *Tonindustrie Zeitung* in 1891:

Bodies.......... $0.3—0.4\ RO.\ \ 1\ Al_2O_3.\ \ 6.2—7.4\ SiO_2$
Glazes.......... $1\ RO.\ \ 0.41—0.55—0.59\ Al_2O_3.\ \ 3.66—4.42—5.04\ SiO_2$

The research of Oscar Kosert, published as a book, "Nippon Togio" (Technology of Japanese Pottery), is a valuable contribution. His investigations were solely based on bodies. One of the results of his investigations was to show that the way of obtaining samples was not satisfactory. The non-uniformity of the burning temperature in different parts of the kiln is great in Japanese kilns as compared with those of European types.

TABLE I—CHEMICAL ANALYSIS OF JAPANESE PORCELAIN BODIES

(Descriptive details of minor importance about the variety of the samples are omitted by the abstractor)

No. of Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Loss on Ignition	Total
				Aichi Prefecture					
1	66.96	21.58	0.74	0.31	0.10	3.82	1.67	4.89	100.07
2	67.75	20.62	0.64	0.32	0.10	4.21	1.87	4.47	99.98
3	69.27	19.30	0.69	0.50	0.12	4.52	1.92	3.77	100.09
4	68.89	19.30	0.67	0.53	0.18	4.75	1.60	4.17	100.09
5	69.29	18.46	0.66	0.64	0.12	4.60	2.09	4.19	100.05
6	69.37	18.95	0.72	0.76	0.14	4.31	2.21	3.67	100.13
7	70.79	18.10	0.64	0.23	0.20	4.38	1.01	4.65	100.00
8	69.18	18.76	0.67	0.44	0.12	4.34	2.92	3.91	100.34
				Gifu Prefecture					
9	65.80	21.56	0.89	0.23	0.05	3.92	2.71	5.07	100.23
10	67.92	20.11	0.78	0.23	0.06	4.23	2.80	4.16	100.29
11	68.74	19.52	0.76	0.29	0.08	4.29	3.15	3.59	100.42
12	64.49	23.00	0.56	0.39	0.16	4.09	2.89	4.76	100.34
13	66.42	21.24	0.44	0.80	0.07	4.21	2.95	4.04	100.17
14	66.54	20.81	0.47	0.57	0.14	4.92	2.13	4.52	100.10
15	69.80	18.73	0.70	0.37	0.25	4.28	2.29	3.45	99.87
16	70.26	18.25	1.04	0.32	0.14	4.30	1.51	4.37	100.19
17	66.68	21.28	0.78	0.33	0.17	3.89	1.50	5.48	100.20
18	67.81	20.31	0.82	0.39	0.15	4.15	1.65	4.63	99.81
19	68.27	19.33	0.75	0.42	0.14	4.47	2.09	4.50	99.97
20	67.75	20.12	0.86	0.31	0.05	4.70	1.91	4.53	100.23
21	71.72	17.33	0.82	0.26	0.06	4.72	2.35	3.17	100.43
22	68.23	20.22	0.63	0.46	0.06	3.79	2.47	4.51	100.37
23	70.53	18.44	0.55	0.33	0.15	3.81	2.35	4.06	100.22
24	70.26	18.39	0.58	0.40	0.07	4.68	2.52	3.51	100.41
25	65.74	22.42	0.55	0.21	0.07	3.87	2.19	5.22	100.27
26	66.55	22.08	0.59	0.29	0.09	4.02	2.24	4.33	100.19
27	66.42	22.12	0.44	0.17	0.05	4.38	2.32	4.21	100.12
28	66.37	21.60	0.52	0.16	0.06	4.53	2.50	4.52	100.26
29	65.81	22.41	0.61	0.33	0.12	3.78	2.82	4.38	100.26
30	63.58	23.03	0.63	0.68	0.15	4.52	2.10	5.32	100.03
31	65.92	22.10	0.67	0.56	0.06	3.38	3.49	4.11	100.29
32	70.87	18.61	0.49	0.41	0.06	4.30	1.73	3.74	100.21
33	69.12	18.25	1.11	0.23	0.10	5.75	2.00	3.48	100.04
34	69.45	18.32	1.42	0.34	0.07	4.06	2.57	3.80	100.03
35	67.92	19.72	1.03	0.63	0.05	3.90	2.57	4.25	100.07
36	65.75	21.46	0.61	0.73	0.17	3.67	2.96	4.70	100.05
37	66.69	20.55	0.88	0.36	0.10	4.14	3.12	4.24	100.08
38	66.22	21.42	0.82	0.24	0.08	3.72	3.00	4.61	100.11
39	68.37	19.87	0.72	0.34	0.05	4.90	2.61	3.40	100.26
40	68.85	19.41	0.67	0.34	0.07	4.87	2.82	3.36	100.39
41	64.67	22.86	0.64	0.51	0.30	2.80	2.86	3.34	99.98
42	65.32	22.52	0.40	0.45	0.15	3.35	3.10	5.77	100.06
43	65.88	21.70	0.32	0.79	0.28	3.14	3.68	4.35	100.14
				Saga Prefecture					
44	73.31	17.15	0.86	0.67	0.30	3.86	0.59	3.26	100.00
45	69.13	19.53	0.80	0.75	0.34	4.29	1.30	4.08	100.22
46	74.74	16.93	0.89	0.14	0.16	3.48	0.39	3.47	100.20
47	75.37	16.20	0.89	0.39	0.08	3.34	0.78	3.14	100.19
48	73.56	18.53	0.49	0.32	0.04	3.20	0.51	3.29	99.94
49	74.78	17.64	0.59	0.20	0.05	3.07	0.70	3.06	100.09
50	74.87	17.26	0.67	0.37	0.06	2.77	1.01	3.51	100.52
51	76.24	16.64	0.76	0.36	0.09	2.25	0.62	3.40	100.36
				Kioto					
52	73.54	16.62	0.52	0.20	0.07	4.06	2.08	3.11	100.20
53	75.46	15.57	0.63	0.24	0.12	2.90	1.88	3.40	100.20
54	70.36	18.99	0.81	0.25	0.10	4.53	1.34	3.80	100.18
				Idzushi					
55	71.00	19.08	1.09	0.75	0.20	2.12	1.08	4.75	100.07
				Tobe					
56	74.94	16.32	1.08	0.51	0.25	3.11	0.71	3.18	100.10
57	72.32	18.69	0.49	0.59	0.16	3.36	1.02	3.69	100.32
				Hira Kiyomidzu					
58	74.64	15.67	0.69	1.08	0.51	2.02	2.02	3.44	100.07
59	73.10	16.54	1.18	0.97	0.34	1.82	1.62	4.44	100.01

TABLE II—CORRESPONDING MOLECULAR FORMULAE

	When $Al_2O_3 = 1$		When $RO = 1$	
No. of Sample	RO	SiO_2	Al_2O_3	SiO_2
1	0.36	5.26	2.80	14.73
2	0.41	5.57	2.43	13.54
3	0.48	6.08	2.08	12.65
4	0.48	6.05	2.10	12.68
5	0.54	6.36	1.86	11.84
6	0.53	6.20	1.88	11.67
7	0.41	6.63	2.46	16.33
8	0.57	6.25	1.77	11.01
9	0.43	5.17	2.33	12.03
10	0.49	5.72	2.06	11.77
11	0.54	5.96	1.85	11.00
12	0.45	4.75	2.23	10.58
13	0.52	5.22	1.92	10.01
14	0.49	5.42	2.03	11.00
15	0.52	6.32	1.93	12.16
16	0.44	6.52	2.25	14.69
17	0.36	5.31	2.73	14.66
18	0.40	5.66	2.50	14.14
19	0.49	5.98	2.05	12.28
20	0.44	5.71	2.25	12.85
21	0.56	7.01	1.80	12.63
22	0.45	5.72	2.20	12.60
23	0.49	6.48	2.06	13.32
24	0.55	6.48	1.81	11.73
25	0.37	4.97	2.68	13.36
26	0.40	5.11	2.51	12.80
27	0.41	5.13	2.46	12.62
28	0.44	5.21	2.28	11.85
29	0.43	4.98	2.32	12.03
30	0.43	4.68	2.31	10.79
31	0.48	5.05	2.09	10.54
32	0.45	6.45	2.21	14.27
33	0.56	6.42	1.79	11.48
34	0.52	6.43	1.94	11.77
35	0.49	5.84	2.03	11.82
36	0.49	5.14	2.02	10.40
37	0.51	5.50	1.95	10.72
38	0.45	5.24	2.23	11.67
39	0.52	5.83	1.92	11.16
40	0.55	6.01	1.81	10.87
41	0.41	4.79	2.42	11.61
42	0.44	4.92	2.27	11.14
43	0.50	5.14	2.02	10.41
44	0.42	7.24	2.41	17.42
45	0.45	6.00	2.24	13.46
46	0.30	7.48	3.34	24.99
47	0.36	7.88	2.79	21.97
48	0.27	6.73	3.71	24.95
49	0.28	7.18	3.55	25.50
50	0.32	7.35	3.15	23.16
51	0.26	7.76	3.83	29.79
52	0.50	7.50	1.98	14.86
53	0.45	8.21	2.23	18.29
54	0.41	6.28	2.43	15.24
55	0.31	6.30	3.20	20.18
56	0.37	7.78	2.67	20.78
57	0.36	6.55	2.75	18.04
58	0.56	8.07	1.79	14.42
59	0.44	7.49	2.33	17.07

The varieties of bodies and glazes burned in Japanese kilns are plural and not single, as is generally found in Europe. At least two or three, sometimes four or five, varieties are found, each of which has a different burning point to meet the different temperatures of the successive sections of the kiln. For this reason, a great number of samples of varieties are important for the study of Japanese porcelain. There are a few reports as to the chemical compositions of Japanese porcelain; however, they do not give clear information about the bodies and glazes.

Y. Kitamura has devoted many years in confirming the chemical compositions of samples of all varieties from all representative localities, covering all typical lines of Japanese porcelain. From the investigations, he concluded some other formula than that of Seger should be applied to them.

Tables I and II show the analytical results of the bodies of fifty-nine varieties—8 from Aichi, 35 from Gifu, 8 from Saga Prefecture, and the rest from Kioto, Idzushi, Tobe and Hira Kiyomidzu. The limits of compositions in their molecular formula classified according to their localities are shown in Table III.

He analyzed all crude glazes before burning. There are 8 samples from Aichi Prefecture, 8 from Saga, 4 from Ehime and 5 from Yamagata. Their chemical compositions are given in Table IV.

---

*Abstract from "The Chemical Technology" (Kwagaku, Kogei), Vol. 2, No. 7, July, 1918.

TABLE III.

	RO	Al_2O_3	SiO_2	No. of Samples
Aichi Prefecture	0.36—0.57 or 1	1 1.77—2.80	5.26— 6.63 11.01—16.33	8
Gifu Prefecture	0.36—0.56 or 1	1 1.79—2.73	4.68— 7.01 10.01—14 69	35
Saga Prefecture	0.26—0.45 or 1	1 2.24—3.85	6.00-- 7.88 13.46—29.79	8
Kioto Prefecture	0.41—0.50 or 1	1 1.89—2.43	6.28— 8.21 14.86—18.29	3
Ehime Prefecture	0.36—0.37 or 1	1 2.67—2.75	6.55-- 7.78 18.04—20.78	2
Yamagata Prefecture	0.44—0.56 or 1	1 1.79—2.33	7.49— 8.07 14.42—17.07	2

TABLE IV—RESULTS OF ANALYSES OF JAPANESE PORCELAIN GLAZES

No. of Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Loss on Ignition	Total
Aichi Prefecture									
1	72.49	13.48	0.42	3.79	0.18	3.53	3.34	2.98	100.25
2	69.47	14.33	0.37	4.66	0.30	3.25	4.07	3.86	100.31
3	68.84	14.73	0.23	5.54	0.25	3.58	3.53	3.62	100.32
4	75.52	10.92	0.24	3.40	0.17	4.71	2.27	2.86	100.09
5	72.45	11.11	0.27	4.77	0.26	4.42	2.76	3.94	99.98
6	69.56	11.67	0.25	6.18	0.33	4.80	2.62	4.71	100.12
7	76.26	9.98	0.46	4.04	0.27	3.45	2.42	3.30	100.18
8	65.02	12.08	0.46	6.61	0.37	5.75	4.17	5.60	100.06
Saga Prefecture									
9	69.17	14.26	0.80	4.71	0.10	1.85	3.07	6.28	100.24
10	64.92	14.46	0.68	6.97	0.10	1.86	3.67	7.53	100.19
11	62.64	14.66	0.28	7.70	0.17	1.64	5.49	7.41	99.99
12	65.28	13.52	0.50	7.58	0.36	2.39	3.43	7.02	100.08
13	65.59	13.53	0.51	7.47	0.20	2.42	3.57	6.77	100.06
14	69.25	15.12	0.57	4.37	0.16	2.31	2.65	5.71	100.14
15	65.07	13.84	0.40	8.32	0.16	1.29	3.97	7.11	100.16
16	64.19	13.20	0.78	7.85	0.32	3.15	3.08	7.56	100.13
Ehime Prefecture									
17	63.67	13.27	0.42	9.94	0.20	1.45	2.53	8.59	100.07
18	57.17	11.75	0.62	14.00	0.13	1.50	2.83	12.07	100.07
19	54.29	11.56	0.40	16.01	0.21	1.37	2.77	13.75	100.36
20	50.71	12.03	*	15.99	1.09	2.60	1.87	14.40	100.02
Yamagata Prefecture									
21	66.72	12.66	0.59	7.86	0.62	2.01	1.60	8.12	100.18
22	62.51	12.61	0.87	9.70	0.70	2.12	1.90	9.62	100.03
23	59.62	12.13	0.83	2.73	0.72	2.07	1.63	2.29	100.02
24	56.78	12.07	0.65	13.53	0.84	1.92	1.66	12.71	100.16
25	55.27	12.45	0.78	13.96	0.91	1.83	1.89	12.89	99.98

* Fe_2O_3 0.94, MnO 0.38.

TABLE V—CORRESPONDING MOLECULAR FORMULAE

No. of Sample	When Al_2O_3 = 1 — RO	When Al_2O_3 = 1 — SiO_2
1	1.24	9.11
2	1.36	8.22
3	1.39	7.92
4	1.42	11.72
5	1.66	11.05
6	1.82	10.10
7	1.58	12.94
8	2.16	9.12
9	1.11	8.22
10	1.45	7.61
11	1.72	7.24
12	1.70	8.18
13	1.67	8.21
14	1.01	7.76
15	1.70	7.96
16	1.79	8.23
17	1.83	8.12
18	2.75	8.25
19	3.09	7.95
20	3.14	7.14
21	1.63	8.92
22	1.97	8.39
23	2.32	8.32
24	2.62	7.97
25	2.64	7.52

The limits of compositions according to their localities are as follows:

TABLE VI.

Aichi Prefecture	1.24—2.16 RO	1 Al_2O_3	7.92—12.94 SiO_2
Saga Prefecture	1.01—1.79 RO	1 Al_2O_3	7.24— 9.12 SiO_2
Ehime Prefecture	1.83—3.14 RO	1 Al_2O_3	7.14— 8.35 SiO_2
Yamagata Prefecture	1.63—2.64 RO	1 Al_2O_3	7.52— 8.92 SiO_2
Total	1.01—3.14 RO	1 Al_2O_3	7.14—12.94 SiO_2

According to the above analysis, the Japanese porcelains have wider ranges of chemical composition both in bodies and glazes than have hitherto been believed by the ceramists. The new limits for them are as follows:

Bodies	0.26—0.57 RO	1 Al_2O_3	4.68—8.21 SiO_2
Glazes	1 RO	0.32—0.99 Al_2O_3	2.27—8.26 SiO_2

From the nature of their body materials, Japanese porcelains may generally be divided into two classes: those bodies consisting of strongly plastic clays (their commercial names are Gainome and Kibushi) of one or two kinds, or with feldspar and quartz; and those having bodies consisting of quartz porphyry, or decomposition products of igneous rocks resembling the above, or these together with some auxiliary materials.

The majority of the so-called Japanese porcelains belong to the first class, which cannot be expressed by the old formula, and Seger's formula applies only to porcelains of Saga Prefecture.

The composition of glazes, on the whole, shows a considerable discrepancy with Seger's formula, and the author's report furnishes definite information.

HOW TO IMPROVE THE PORCELAIN FROM THE STANDPOINT OF CHEMICAL COMPOSITION

To improve the porcelain, he took the physical properties into consideration, for instance the percentage of breakage during transportation, durability, etc. Further, he compared these analytical results of the Japanese porcelains with the best ones having international reputations and tabulated the formulæ as follows:

Japanese porcelain, first type	0.36—0.57 RO	1.00 Al_2O_3	4.68—7.01 SiO_2
Japanese porcelain, second type	0.26—0.45 RO	1.00 Al_2O_3	6.00—7.88 SiO_2
Sevres, Vienna	0.3 —0.35 RO	1.00 Al_2O_3	2.8 —3.5 SiO_2
Limoges, etc	0.2 —0.3 RO	1.00 Al_2O_3	4.2 —4.8 SiO_2

For the best European porcelain bodies the value of RO is 0.2—0.35 equivalent and that of SiO_2 is 2.8—4.8 when Al_2O_3 is taken as unity. The first class Japanese porcelain bodies contain more RO and SiO_2 than those of Europe and the second class Japanese porcelain bodies usually contain about the same value of RO and sometimes a little more, but considerably greater value for SiO_2 and sometimes almost twice as much as those of Europe.

The presence of an excess of basic components in a body lowers the softening temperature of the body and makes it vitreous, thus resulting in the disadvantages of poor resistance to shock and other mechanical treatment. The silica has the property of rendering the body brittle, if present in excess, to a much greater extent than alumina.

To improve the mechanical properties of Japanese porcelain one possible way is to correct their composition by changing the proportions of the raw materials and bring them nearer to those of the higher grades. For the first class Japanese porcelain bodies, the alumina comes from plastic clay (Gainome clay), basic components from feldspar, silica from quartz. An increase of alumina and decrease of bases and of silica mean, respectively, an increase of Gainome clay and a decrease of feldspar and quartz in the mixing operation of the raw materials. By increasing the percentage of Gainome clay over the present proportion, plasticity is increased. The dyeing and burning shrinkages become considerable and unfavorable color effect is found in the burnt products. For these reasons, it is practically impossible to obtain good bodies by increasing their content of alumina over the present proportion by using the old materials alone.

The discovery of these Korean clays is, indeed, an important contribution to the ceramic industry. Their properties, compositions and application in porcelain bodies are fully described in Reports No. 10 and No. 13 of the Industrial Research Laboratory, Department of Agriculture and Commerce, Japan.

For the second class of Japanese porcelain the raw materials are simply quartz porphyry of varied decomposition. In order to decrease the percentage of silica, it is necessary to introduce aluminous materials into the old body clays. These body materials are generally not of strong plastic nature, so the addition of strongly plastic clay should be to a certain extent effective.

When the silica content is considerably too large, the introduction of alumina, necessary to counterbalance the brittling effect of silica, in the form of plastic Gainome clay is not satisfactory, because of excessive drying and burning shrinkages. It is advisable to apply strong plastic Gainome clay mixed with some weak plastic chosen Korean clay.

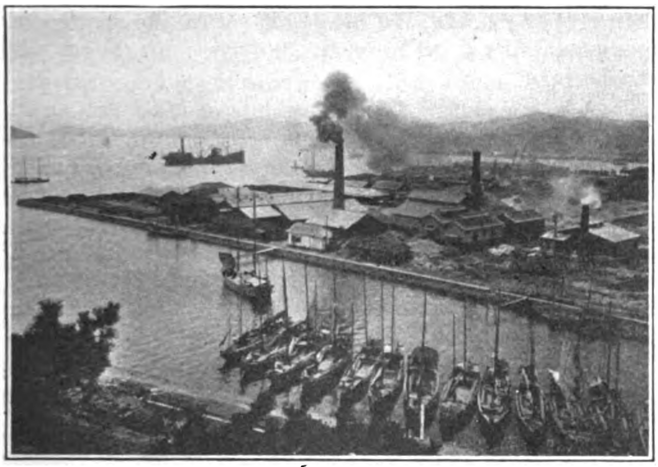
For those of the second class of Japanese porcelain bodies which have an excess amount of basic ingredients, the introduction of clayey substance reduces the percentage of base in the bodies, but for those not having an excess of basic ingredients, corresponding amounts of feldspar are necessary to maintain the desired percentage of bases.

Refractories Industry in Japan

By T. Kurahashi

WHILE every line of the chemical industry is rapidly growing and developing in Japan, the refractories industry has reached the highest development.

The manufacture of refractory material either in brick form or other is not a new industry there. About a thousand years ago Japanese began to manufacture refractories for iron and copper metallurgy, and made the casting of the "Daibutsu," the gigantic bronze statue of Buddha. However, generally speaking, this industry is classified as one of the imported industries since Japan has opened her doors to Western civilization.


UNO FIREBRICK CO.. INLAND SEA OF JAPAN

The Shinagawa Shiro-renga Kabushiki Kaisha (Shinagawa Firebrick Co., Ltd.) is the leading corporation of the brick industry and became the most important since the consolidation with the Nippon Yogyo Kabushiki Kaisha (Japanese Ceramic Co., Ltd.).

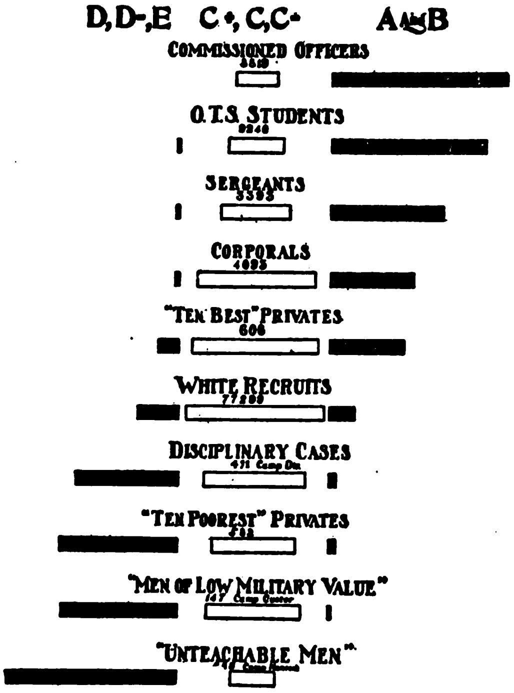
After the war broke out, and the chemical and metallurgical industries increased rapidly, many refractory plants were established. The Uno Taikarenga Kabushiki Kaisha (Uno Firebrick Co., Ltd.) is one of the most important.

Unfortunately, Japan has no variety of raw materials for special refractories, such as bauxite, magnesite, ganister, graphite, etc., so that most of the firebrick plants are not concerned in these special types of ware.

Tests of Men

WE GIVE herewith a few graphs taken from a recent number of *Science* on the "Measurement and Utilization of Brain Power in the Army" as developed by Major Robert M. Yerkes. They refer to psychological tests made of men in the Service, and their value is justified. They indicate: grade A, very intelligent; B, intelligent; C+, above average; C, average; C— below average; D, unintelligent, and D— and E, a mental age of from 7 to 10 years.

Without doubt the tests might be improved upon for special purposes, and those that are given do not include enough in number to demonstrate complete general averages. Nevertheless, as shown, they are confirmatory of what many of us have been thinking with more or less seriousness for a long time; that men in class D and under are not fit to rule. If all D— and E men had been rejected at the start, disciplinary cases would have been largely avoided, with all the delay, disturbances and expense attached to the proceedings; and the ranks of "poorest privates," "men of low military value," and "unteachable men" would have been greatly reduced.



PROPORTION OF LOW, AVERAGE AND HIGH GRADE MEN IN TYPICAL GROUPS

We have been too neglectful of our D and E men and women in more ways than one. In mind they are children, and they are numerous, but we do not know how many they are, or which is which. The tests to determine this, though still inadequate, are better than we have been disposed to believe.

The present bolshevism and its associated I. W. W. anarchy are based upon the principle of rule by classes D and E. We make this as a postulate on the conviction that a psychological examination of the enrolled members of the I. W. W. by competent and impartial authorities would show a predominance of types D and E. It is easy enough to prove the contrary if the facts do not warrant the assertion. Now rule by men and women below type C is not to be endured unless those of types C and above are killed off, and then savagery is bound to prevail, for children are, in a way, savages. In parts of Russia this practice seems to obtain now. Efforts have been made to establish it in the textile cities of Lowell and Lawrence, Mass., and there has lately been an unsuccessful attempt to make a start of it in Seattle.

We must not think for a moment that a man is of class D or E because he is a laborer, or that he is out of these classes if he is rich and in authority. Note, please, that over half of the enlisted men are above C—, and that a large proportion of sergeants and corporals are in classes A and B. Also we must bear in mind the number of commissioned officers in C and C+. We have not yet discovered the golden rule to fit men in places where they belong, but these tests seem likely to help us toward it.

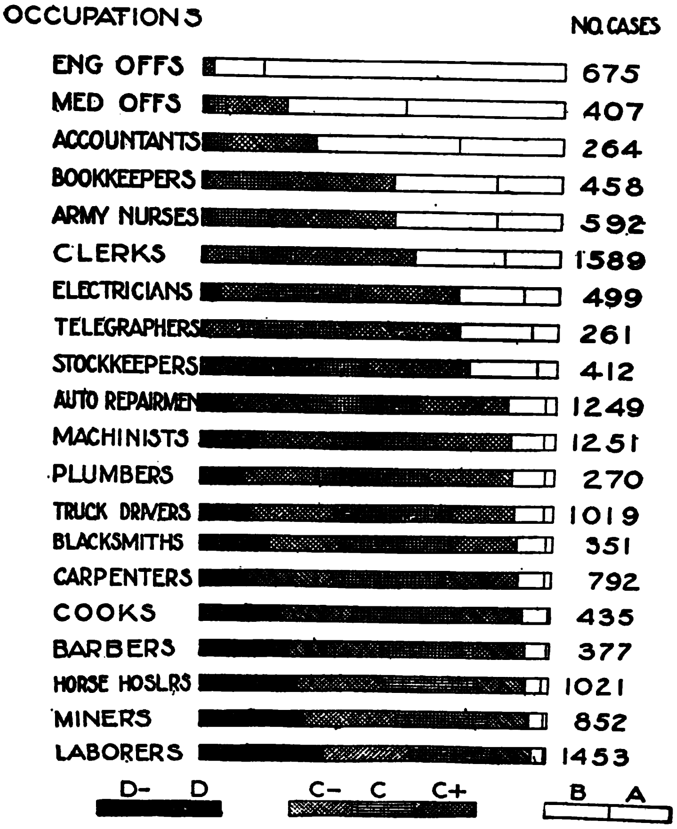
The tests are probably weakest in ethics and esthetics. With the latter we have not much to do as yet in industry and engineering. But with ethics we have constantly to do; and ethics has a wider scope than the Ten Commandments of Exodus. The A and B mind may be unethical, and cause a veritable deluge of disaster without ever reaching the stage of discipline. The war and all its consequences are directly traceable to the disregard of ethics by the German nation and its people. Tests are unlikely to be a gage of ethics, because nearly everybody, whether good or bad, or wise or stupid, claims to be just and fair, and will use what intelligence he has to prove it in examination. Justice and fairness are functions of ethics. The chances are, however, that minds of the A and B types, even if unethical, will avoid doing things that will get them into trouble, and that their acts will be guided by the ethical standards of public opinion.

Here we have a new method of gaging men that is free from favoritism, and that judges each one for what he is. It does not ask who his father was, or whether he is rich or poor. He does not require a college degree or a high school diploma to rank A, nor will a doctorate in philosophy assure him of this standing. It provides a means to aid in avoiding incompetence in authority. But at the same time it carries with it certain obligations.

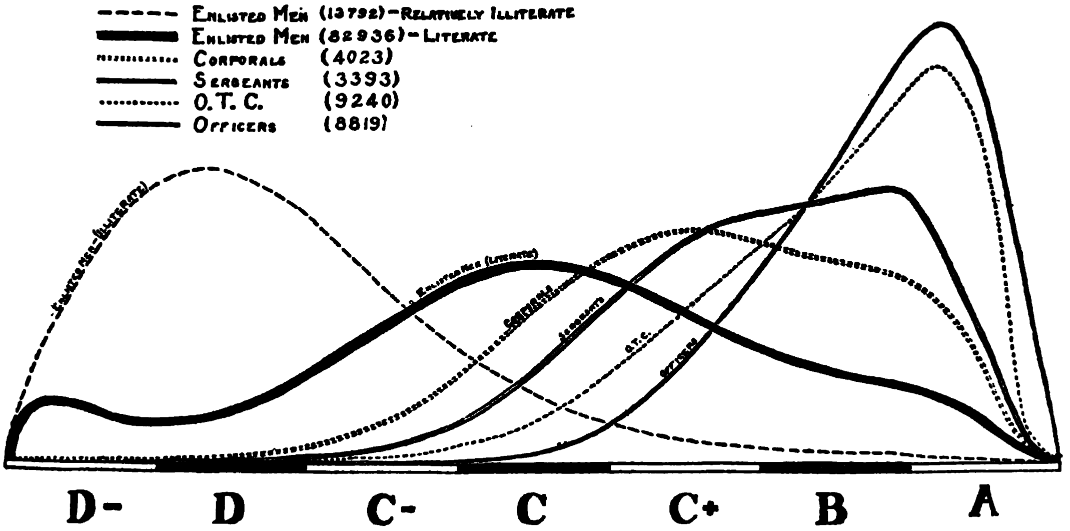
Two duties lie immediately before us in industry, and they are pressing, exceedingly pressing. We must test out the men we employ in order to fit them into their proper places. We must get rid of the system of hiring and firing by foremen, and we must know our men better.

That is one duty. The other is, we must set apart work that can be performed, at a living wage, by the D and E classes of men. They must be cared for, and watched, kindly but firmly. They should never be put into places of authority, whether they be rich or poor; and every such case should be tested and recorded. Then the A and B men should have the first chances of advancement, provided they are physically fit, and ethically adequate.

Crooks belong to a special class by themselves, and only the Lord and Tom Osborne know what to do with them.



RELATION OF OCCUPATION TO INTELLIGENCE



DISTRIBUTION OF INTELLIGENCE RATINGS IN A TYPICAL ARMY GROUP, SHOWING THE VALUE OF THE TESTS IN THE IDENTIFICATION OF OFFICER MATERIAL

Some Points Regarding Calorimeter Efficiency*

Description of the Sources of Calorimetric Errors—Advantages of Different Types of Calorimeters for Moderately High Precision Commercial Work—Practical Conclusions—Superiority of a Calorimetric Installation With a Stirred, Thermostated Jacket and an Electric Thermometer

BY WALTER P. WHITE

THE use of the calorimeter is to-day extending rapidly, especially for fuel testing. At the same time some new types of calorimeters are being introduced whose value varies greatly, according to the work to which they are put. There is thus a double reason for considering the sources of calorimetric error and the advantages of different types of instrument. The present paper attempts this task, and does so with reference rather to the moderately high precision desirable in commercial work than to the higher precision attained in special researches.

Calorimetric experiments are practically always done by passing the heat to be measured into a known mass of water and observing the resulting temperature rise. The heat, ΔQ, is then determined in accordance with the well-known equation $\Delta Q = C\Delta\theta$, where $\Delta\theta$ is the temperature change and C the capacity for heat of the calorimetric body; that is, of the water together with the containing vessel. This determination would involve nothing but a couple of temperature measurements were it not for the fact that there is no insulator for heat, and therefore there is practically always some heat flowing to or from the calorimeter. This thermal leakage must be determined, usually by a combination of observations and calculations. It causes less actual error than is often supposed, but it dominates the whole subject of calorimetry, and is responsible for nearly all the characteristic features of calorimetric practice. Thus, in order to treat the leakage in a definite way the surrounding temperature must be controlled more or less; then, in order to prevent the leakage from making the calorimeter temperature non-uniform and therefore uncertain, there must be stirring, which is the reason for using a liquid. This, in turn, may bring difficulty from evaporation and irregular stirring, and, finally, some temperature differences remain uncorrected (especially in the solid parts) constituting "lags," which are, mathematically, the most complicated part of the whole subject, though they can, fortunately, be handled very simply in work of moderate precision.

SOURCES OF ERROR

Aside from blunders and exceptional occurrences, the sources of error in ordinary calorimetry seem completely covered by the following list:

A. The main temperature measurements.
B. The value taken for the heat capacity of the calorimetric body.
C. The associated determination.
D. The thermal leakage or its consequences, including:
  a. Control of the external temperature.
  b. Control of the calorimeter temperature (i.e., efficiency of stirring).
  c. The heat produced by stirring (which may be irregular, owing to irregular speed of stirring).
  d. Evaporation.
  e. Lags, if neglected or varying.

TEMPERATURE MEASUREMENT

A. The temperature measurement seems to call for little comment, save perhaps to say that from two to four individual observations are needed, so that the final error may be two or four times that of a single reading, though the average final error will not be so large as that. Thus, a mercury thermometer, if accurate to 0.001 deg., will, in itself, give a precision of one per mille or a little better with a temperature rise of 4 deg.; this is, however, rather high precision for a mercury thermometer. The electric (resistance) thermometer will do better—about ten times as well with the best instruments in competent hands. It of course requires a more elaborate installation. Many observers, however, consider the precautions and corrections needed with it less objectionable than those involved with the mercury thermometer, and the extra precision of the electric thermometer is a desirable thing, even in cases where the other may seem good enough. A precision which is just enough and no more for the purpose in hand looks very shrewd and economical on paper, and may prove not unsatisfactory so long as everything goes well; but if unexpected errors need investigation or checks upon the accuracy are desired, as is pretty certain to happen sooner or later, it is exceedingly comfortable to have even a fourfold or fivefold excess of precision, and in as many departments of the work as possible. The thermo-electric thermometer is not only capable of higher ultimate precision than the resistance thermometer in measuring small temperature differences, but is, to judge from my own experience, more reliable, and less troublesome in its need for precautions, though in some other evident ways it is less convenient. The methods necessary with it, however, are not so generally understood, and it is not regularly manufactured at present.

HEAT CAPACITY OF THE CALORIMETRIC BODY

B. For determining the heat capacity of the calorimetric body the practice of calibration by means of a known quantity of heat, obtained either electrically or by means of a standard substance, has so many advantages, and has already become so widely used, that no other seems to deserve consideration. With this method, if uniform conditions are preserved, the error of the calibration becomes little more than the average error of a number of determinations, which can be made as numerous as is desired.

C. The associated determination must be considered for a fairly evident reason. There is no such thing as bottling up a quantity of heat for subsequent measurement; heat cannot even be passed, unchanged, directly from one calorimeter to another. The heat must be produced as measured, and the only way to give the measurement significance is to express it as a ratio between the quantity of heat and the quantity of the thing (reacting chemical, electric energy, etc.) yielding the heat. An error in one of the terms of this ratio has the same final effect as a corresponding error in the other. This is merely a formulation of what is pretty generally understood in individual cases. In commercial coal testing, for instance, it is generally recognized that the sampling of the coal is often the greatest source of uncertainty, and it is futile to strive for a calorimetric precision very far ahead of the uniformity which it seems worth while to seek in the sampling.

---

*Journal, Franklin Institute, Vol. 186, p. 279.

THERMAL LEAKAGE

D. The thermal leakage and its calculation are responsible, as has been said, for most of the problems and complications in calorimetry. In calculating, the leakage is taken as the product of the leakage modulus, or rate of leakage per degree of thermal head (thermal head is the difference of temperature between calorimeter and environment) multiplied by the integrated value of the thermal head for the experimental period. The standard method is to determine the leakage modulus by rating-period observations on the rate of cooling of the undisturbed calorimeter; if two such rating-periods are used, it is possible to determine the thermal head without measuring the environing temperature, provided this temperature does not change appreciably during the experiment. This precedure also eliminates the effect of the heat produced by the stirring, which would otherwise need especial attention. The method is familiar, and does not need detailed consideration here. This method is almost necessary if the environment consists of several indefinite bodies at different temperatures, but it involves having three observation periods. If, however, the leakage modulus is the same from day to day, and if the environing temperature is measured, or is kept at a known value by a thermostat, the leakage can, after suitable preliminary work, be determined merely from observations on the calorimetric temperature during the experimental period, and no other period is needed, unless occasionally as a check. Of course, this demands first that the environment be all at a single definite temperature—that is, practically, that it be a stirred body of water more or less completely enclosing the calorimeter (though with an air space between, of course), and second that the calorimeter always contain the same amount of water and always be located, to a fraction of a millimeter perhaps, in the same position within the jacket.

ACCURACY OF SPECIAL METHOD

To determine the leakage in this way not only saves time and labor, but may promote accuracy by eliminating the errors of the temperature measurements needed in observing the leakage rates. That is to say, instead of a rate determined separately with some error for each experiment, the observer uses a rate determined once for all with more accuracy by numerous experiments. Using this method, the Bureau of Mines observers have, as they state, usually attained in their regular routine procedure an agreement of 1 in 1000. Of course, this precision was realized only where the sampling error was eliminated. This method, it may be added, should not be relied upon in any particular installation until it has been shown that the leakage modulus is in fact as constant as it needs to be. Other things than the position of the calorimeter may be of importance here. For instance, if metallic parts of any kind run from the calorimeter through the jacket to the air of the room outside it, a change in room temperature is very apt to alter the leakage rate unless proper precautions are taken. Evaporation is prevented in the Bureau of Mines calorimeters.

If the determinations made are nearly the same day after day, the temperature during the experimental period will always rise along almost the same curve, and its integrated value may without error be taken as the same for any given total temperature rise. If, in addition, the jacket temperature and the initial calorimeter temperature are always the same, the integrated thermal head will always bear the same relation to the total temperature, and the amount of thermal leakage will be simply a certain constant (and small) percentage of the total temperature rise. No attention, therefore, need be paid to the thermal leakage in working up the results. This is essentially the Bureau of Mines procedure. This treatment of the thermal head saves only a little labor, not time or error. Another important variation of the general method is obtained when the total value of the thermal head for the experimental period is kept very small. Since this value of the thermal head is the multiplier of the leakage modulus, a small value of it makes uncertainty in the modulus of very little importance; hence accuracy is higher while at the same time the modulus need not be very constant. In order to keep the total value of the thermal head small, the calorimeter is started at a suitable temperature below that of the jacket; the head is then first negative and afterward positive. It does not seem practical to use this method without observing the thermal head, nor without preventing evaporation. Hence this variation is a little more laborious, as well as more accurate, than the other. It does not take appreciably longer, and it avoids the thermostat.

CONTROL OF EXTERNAL TEMPERATURE

D, a. The temperature change from leakage of a well-designed calorimeter of ordinary size will be less than 0.015 of the thermal head in 5 min.; hence for 5-min. experimental periods the uncertainty of the jacket temperature may be at least thirty times that in the principal readings. Evidently any difficulty there may be as to this temperature will be a matter of control or uniformity, and not of measurement.

STIRRING

D, b and *c.* The matter of stirring seems fairly well covered by the recommendation of the joint committee on coal analysis of the American Society for Testing Materials and of the American Chemical Society[1], that the stirring be vigorous enough to heat the calorimeter nearly 0.001 deg. per minute, and regular enough so that the variation in heat is negligible. This is certainly sufficient with a reasonably well-designed calorimeter. The heat varies as the cube of the speed of stirring, so that a variation of 1 per cent in speed produces a variation of 3 per cent in heat production.

D, d. No data exist as to the relative probable error from evaporation, but this does not seem likely to be serious in commercial work, so long as evaporated water does not condense on the cover and drop back into the calorimeter. The prevention of evaporation is very desirable in work of high precision and is easy enough to be reasonable in nearly all cases, since it can be effected, without the introduction of any other error, by covering the calorimeter with an exceedingly thin metal cover. This cover need not bend down to touch the water, though it may well do so. If it does not, the water should be, to a millimeter, always at the same distance below it—say a centimeter. Covers of wood, rubber or other poorly conducting material have no other recommendation than possible cheapness. (See Walter P. White: "Calorimetric Methods and Devices," *J. Am. Chem. Soc.*, 40, 1888, 1918.) It does not necessarily follow that it is desirable to scrap such covers now in use, however.

---

[1] *Jour. Ind. & Eng. Chem.*, 9, 106 (1917).

Further Practical Conclusions

From the preceding discussion it appears that the uniformity of conditions in the uniform determinations of commercial work is almost sufficient in itself to secure precision, so far as thermal leakage is concerned, since effects which would otherwise be errors tend to cancel. The joint committee report cited above says that the calorimeter jacket "should" contain water which is stirred. There are two different reasons for this. The uniform temperature of a stirred jacket is, of course, desirable, but it might not seem necessary, since an unstirred jacket always started at the same temperature relative to room and calorimeter would be likely to give uniform results. But to have a jacket full of water which is stirred is the easiest way to provide for getting it at the same relative temperature each time; moreover, the provision of this particular feature is seldom likely to prove expensive.

To convert the stirred jacket into a thermostat is more expensive, since it requires a regulator and also demands if it is to be of real value that the jacket be brought above the calorimeter so as to surround it with practical completeness. But the gain in time and labor from using such an installation is very considerable.

The joint committee report advises having the initial calorimeter temperature so far below that of the jacket that the final temperature is less than a degree above it, and the total resultant thermal leak is near zero. Two advantages are attributed to this procedure; one, that evaporation is diminished; the other, that the total leak is small. The diminution of evaporation is as likely to increase the error as to decrease it[3], and the smallness of the total leak is practically of no advantage in the case treated, where two rating periods are supposed to be run, since in that case the total magnitude of the leakage has no effect on the error. This is proved in: Walter P. White: "The Conditions of Calorimetric Precision," *J. Am. Chem. Soc.*, 40, 1877, 1918. Little is lost by thus reducing the total amount of leakage, but it would be misleading, in considering the adoption of this method rather than some other, such as the Bureau of Mines method, to suppose that it had any real advantage in this particular direction.

It has been shown above that where a predetermined value of the modulus is used the reduction of the total amount of leakage does increase the accuracy. That case is not to be confused with the present one, where two rating periods are to be run (or three in all), and was not contemplated in the joint committee report. The reason for the difference in the two cases is this: With a predetermined modulus the heat of stirring is known, and so is the value of the environing temperature. When the direct thermal leakage is made very small its error is also made small, and there is nothing else normally affecting the calorimeter temperature, but with the 3-period method the heat of stirring and the effect of the environing temperature are determined along with the main thermal leakage, and so even if the main leakage is made to disappear the determination of these quantities remains, and its error is in fact about the same whether the total correction is large or small, since the term containing these quantities is not multiplied by the small value of the thermal head. A more complete explanation is given in the reference cited.

A calorimeter has been advertised as "adiabatic" which is characterized mainly by the use of a vacuum-jacketed glass vessel instead of the usual metal cup. To call such an arrangement adiabatic is pure humbug; it has a thermal leakage, which may be one-third or may be one-fourth as great as that of an ordinary calorimeter. To claim some advantage from the smaller leakage is legitimate; for it may enable an equal degree of precision to be reached with less care as to conditions.

Attempts are being made to utilize in commercial work calorimeters which are really adiabatic; that is, in which the jacket temperature can be rapidly changed and controlled so that it can be kept the same as that of the calorimeter during an experiment. Some of the proposed apparatus is admirable in its ingenuity and effectiveness, but there is still reason to doubt if it is worth while. The adiabatic method in calorimetry, like most methods in every subject, differs greatly in value according to the conditions of its use. In aneroid (fluidless) calorimetry and in long-timed determinations it is often absolutely indispensable, but in short experiments its value is much less. If we refer to the sources of error listed in this paper, *A*, *B*, and *C* are scarcely affected one way or the other by the adoption of the adiabatic method; nor are the temperature distribution effects *D, b; D, c,* and *D, e.* Evaporation (*D, d*) is greatly diminished, but easier ways have already been given of securing this result, which is not of first importance, anyway, in commercial work. The control of jacket temperature (*D, a*) will evidently be more perfect where this temperature is not greatly changed, so that here the adiabatic method is actually worse, though the inferiority is probably not serious. One real advantage of the adiabatic method is in ease, not precision, and consists in the avoidance of the labor of calculating the thermal leakage. But in commercial work this advantage is still more easily obtained through a thermostat, as at the Bureau of Mines. Of course, this method calls for a constant leakage modulus, which the adiabatic does not. But the results show that the chances of error from inconstancy of this modulus are very small. The most serious danger of variation in the modulus—that coming from the influence of room temperature changes—is quite as great with the adiabatic method. In uniform short-timed determinations, then, the adiabatic procedure, in return for the expense and manipulation it demands, appears to offer no advantage that cannot be more easily secured in other ways[3].

---

[3] Owing to the fact that the leakage rate differs some 30 per cent, according as evaporation is or is not occurring; that is, suddenly becomes 30 per cent greater when the calorimeter temperature passes above the jacket temperature.

If a massive block of metal is used as the calorimetric body, equalization of temperature is less perfect than with a stirred liquid, but the difficulties and annoyances of stirring and evaporation are completely banished. The relatively imperfect equalization is evidently less serious in the uniform determinations of commercial work, so that for such work this kind of calorimeter might prove very desirable. Féry has proposed such an instrument, using the steel bomb alone as the calorimetric body, and measuring temperature thermoelectrically. In striving for simplicity, as it seems to me, he has attained an altogether unnecessary crudeness in several respects. Apparently, a much more accurate instrument could be realized which would not be harder to manipulate. The final success of such an intrument—that is, its net superiority to existing calorimeters—cannot be guaranteed in advance of actual experience, but the idea seems promising.

In conclusion, it may be said that a calorimetric installation with a stirred, thermostated jacket and an electric thermometer appears thus far to have given the best combination of precision and ease of operation, and that in the main the electric thermometer is responsible for the precision, and the thermostat for the ease of operation.

Geophysical Laboratory,
Carnegie Institution,
Washington, D. C.

An Adiabatic Bomb Calorimeter

By E. B. Holland,* J. C. Reed,† and J. P. Buckley.†

THE USE of calorimeters has become so general in both investigational and trade laboratories and the literature on the subject is so voluminous that it is with some reluctance that one offers additional material for fear of repeating what may have been more ably presented elsewhere. Some nine years ago the Massachusetts Agricultural Experiment Station secured a Berthelot-Mahler-Kroecker calorimeter with copper jacket and accessories, including pellet presses, Richter-Beckmann thermometers, Muencke balance, etc., for use in nutrition work and in the examination of fuels. The apparatus is too well known to require a detailed description. The bomb is of 300 cc. capacity and convenient to handle except in a few minor details. The porcelain lining is the most vulnerable feature. The jacket, however, did not permit the control of temperature required in an adiabatic calorimeter, and the reciprocating stirrer was unsatisfactory.

NEW CONSTRUCTION

A new double-walled copper jacket was constructed by E. A. Thompson of Amherst, the details of which are shown in the illustration. It is provided with an inlet for cold water, an overflow, a screw propeller stirrer belt driven by a slow starting electric motor of ⅛ hp., speed 1800, and a helical electrical resistance heater, which together permit complete control of the temperature of the jacket. The entire amount of water in the jacket circulates freely, as there is no dead space. The heater raises the temperature of the water 1 deg. C. per minute of current use. The cover is of a "two-step" type, copper with hard fiber top and partition, thus providing two superimposed dead air spaces. The thermometer and lens supports are of simple construction and very serviceable.

The copper pail, containing water in which the bomb, stirrer and thermometer are immersed, is insulated from the jacket and accurately centered by means of hard fiber supports. The pail, water, bomb, stirrer, etc., constitute the calorimeter proper, and the hydrothermal equivalent of the metal parts, enamel, glass, etc., together with the water, compose the bomb unit. A rotary stirrer of skeleton construction, with an offset for immersing the thermometer and two sets of blades inclined in opposite directions, effects with the baffle plates on the pail a spiral movement of water horizontally around the bomb. The stirrer is driven at low speed by a secondary belt leading from the screw propeller in the jacket and insures equalization of temperature without the production of an appreciable amount of frictional heat. The wires leading from the bomb are soldered to insulated cylindrical pieces of spring brass which slip over the terminals, displacing the screw connections, and pass out of the jacket through the driving shaft of the rotary stirrer to the desk terminals.

The calorimeter can be easily assembled or dismantled in a few minutes. The water and electrical connections permit convenient control of both screw propeller and rotary stirrers, temperature of jacket, thermometer tapper and ignition.

THERMOMETERS

In the selection of new thermometers for determining the heat of combustion, choice lay between the normal type and the metastatic with an arbitrary zero, such as the Richter-Beckmann. The electrical resistance type which has since come in vogue seems to possess a high degree of accuracy and ease of reading, but was not considered at that time. The latter instrument was developed largely by the Bureau of Standards. The cost, however, precludes its use by many laboratories today.

Normal and metastatic thermometers of substantially the same length scale, 6 deg. range and 0.01 deg. divisions, could be readily procured and were presumably equally sensitive. The normal type of special construction was considered preferable and finally selected. The following specifications were furnished:

Approximate total length	24.0 in.
Length of scale, 16 to 22 deg. C.	10.0 in.
Outside diameter on the scale	0.5 in.
Length below scale plate	8.0 in.

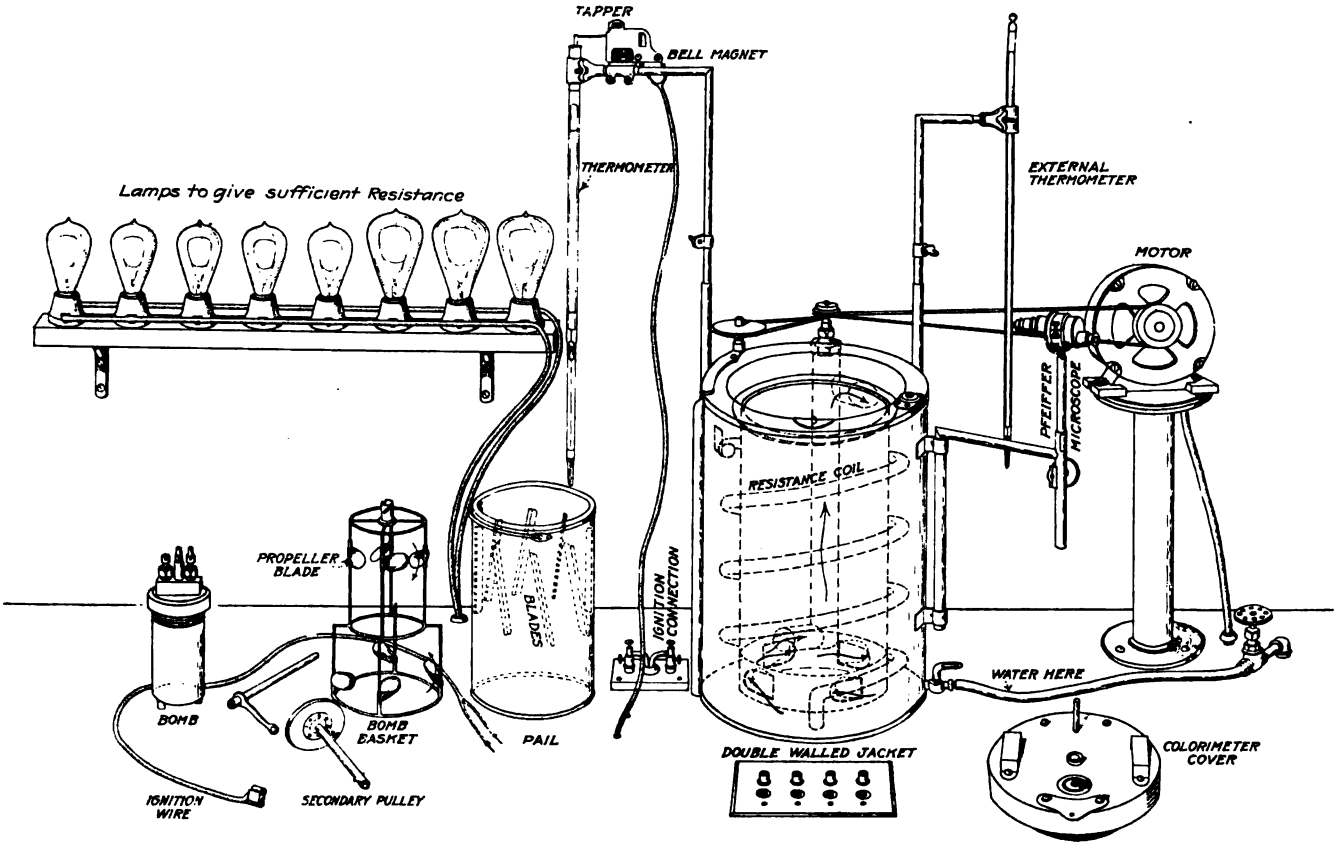
Each thermometer was provided with an expansion bulb, milk glass scale and a metal cap to permit the use of a tapper. After seasoning for several months the thermometers were tested by the Physikalisch-Technischen Reichsanstalt and a certificate of correction for each degree issued.

---

[3] In some recent work of high precision (*Journal Am. Chem. Soc.,* Vol. 39, p. 2110, 1917) the adiabatic method was adopted mainly because a stationary final calorimeter temperature was thought necessary for satisfactory reading of the resistance thermometer. It is safe to say that the necessity, in so far as it existed, may fairly be attributed to some deficiency or peculiarity of the electric installation used, and is not an inevitable disadvantage of that type of thermometer, although the usual installation is not the most convenient that could be used for reading changing temperatures. So far as the precision of commercial work is concerned, there appears to have been no general difficulty in reading changing temperatures, as is indeed shown by the disregard of the possibility of making their reading more convenient.

*Associate chemist, Massachusetts Agricultural Experiment Station.

†Assistant chemist, Massachusetts Agricultural Experiment Station.



ADIABATIC BOMB CALORIMETER

Almost any chemical thermometer graduated to 0.1 deg. C. on milk glass scale or stem will answer for determining the temperature of the water jacket, provided the instrument is reasonably accurate.

The tapper was constructed from an ordinary electric bell clamped to the arm of the thermometer support, the gong removed and a piece of soft rubber inserted in place of the hammer to reduce the force of the blow to the intensity desired. Wet and dry cells having proved unreliable, the tapper was run from a bell ringing transformer giving 5 to 10 volts, 0.75 amp. vibrating and 1.30 stationary. The application of the tapper a few seconds before each thermometer reading prevented any perceptible mercury "lag" or frictional error.

LENS

The lens sent with the original calorimeter for reading the thermometer scale was unsatisfactory. A Galileo telescope, a reading telescope and a so-called "laboratory microscope" were also tried with like results. The ideal instrument should be mounted horizontally, give a clear sharp field of appreciable size when applied to the opaque milk glass scale of the thermometer, not invert the object, magnify sufficiently at 0.01 deg. C. division of the scale (approximately 0.42 mm.), so that it can be readily and accurately divided into 10 parts or read to 0.001 deg. C. (probably equivalent to 15 to 20 diameters), and if possible have a focal distance of about 90 mm., so as to clear the side of the calorimeter jacket. Singly all these requirements were possible, but combined were rather difficult to meet.

The prism tube of a Pfeiffer's dissecting microscope with ocular 201 and a chromatic objective 1-a with special arrangement for varying the focal distance was finally secured. The combination gives a magnification of approximately 4.5 diameters, and a clear field of 48 mm. at a distance of 90 mm. The instrument as a whole is the most satisfactory of any tested, though lacking the necessary magnification. The latter fault will be remedied as soon as higher power can be secured, which so far has been impossible on account of the war.

Amherst, Mass.

Meeting of the Maritime Chemists' Association

At the meeting of the Maritime Chemists' Association held in Sydney, N. S., on July 15 and 16, Mr. A. F. Blake, chief chemist of the Atlantic Sugar Refineries, Ltd., St. John, read a paper on "The Evaluation of Coal," in which he developed an equation based on the analysis of the coal to determine the value as a fuel. He also showed a nomographic chart enabling the solution of the equation to be carried out with a minimum of effort.

Mr. I. C. Mackie, chief chemist of the Dominion Iron & Steel Co., Sydney, read a paper on "The Use of Benzol as Motor Fuel," which appears in a forthcoming issue of the *Canadian Chemical Journal.*

Dr. H. Jermaine Creighton of Swathmore, Pa., read a paper describing the Landreth direct oxidation process for the electro-purification of sewage, showed lantern slides of the plant and gave analytical and bacteriological data showing the efficacy of this method. He also gave cost data for an installation.

A paper by Dr. A. McGill of the Trade and Commerce Department on "The Chemists' War" was read by title.

Committees were appointed to deal with the question of the formation of a section of the Society of Chemical Industry and to approach the Government relative to the representation of the Maritime Provinces and its industries at the forthcoming Exposition at Chicago.

Notes on the Estimation of Metallic Zinc Content of Zinc Dust

BY W. F. EDWARDS

BY USING the Franz Meyer apparatus and observing all of the numerous required details one can obtain quite accurate, consistent results in the chemical analysis of new (unused) zinc dust; and by the exercise of proper care and precautions fairly consistent results can be obtained also on zinc dust that has been used in the process of sherardizing.

However, everything taken into the consideration, the hydrogen gas method is not suited to the estimation of zinc dust, used or unused, in sherardizing. It requires too long time, too much attention to details and too much apparatus. Barometer readings, temperatures, vapor tension corrections, gas absorption corrections, etc., are necessary.

The method of estimating the metallic zinc in zinc dust by the reduction of potassium iodate in dissolving the zinc dust in a strong solution of fixed alkali and subsequent titration of iodine distilled from the acidified solution by sodium thiosulphate, in the main as given in the second edition of "Merck's Reagents, Their Purity and Tests," gives consistent results when proper attention is given to a number of details such as continued shaking during the solution of the zinc dust, proper cooling of the solution of potassium iodide in which the iodine is absorbed when distilled from the acidified solution, and proper attention to connections in and displacement of the air from the distillation apparatus. This method, like the hydrogen gas method, is subject to too many details to be a good working method in sherardizing or other commercial plants.

THE AMALGAM METHOD

The amalgam method gives very uncertain results, but in general it may be said to give too high per cents of zinc oxide and therefore by difference too low per cents of metallic zinc. As usually described the amalgam method depends on the titration of the excess of a measured quantity of standard acid, usually hydrochloric acid. It is not easy to get a definite end reaction in an acid solution containing zinc salts, as the zinc hydroxide formed does not show sharply enough the point at which the acid is neutralized by the standard alkali solution. By titrating the acid solution of zinc salts with standard solution of potassium ferrocyanide to obtain the zinc directly instead of by deduction from the amount of acid used, one can get a definite enough end reaction for practical purposes, if the solution is filtered before titration. However, the amalgam method can only be of value when carried out with careful attention to details in parallel estimations of the "unknown" zinc dust and standard zinc dusts of known metallic zinc content, under identical conditions of reagents, temperature and time. Even under such conditions the results are not even satisfactory for ordinary practical purposes.

THE FERRIC AMMONIUM ALUM METHOD

The method of reduction of ferric sulphate in my hands gave very inconsistent results even when care was taken to run parallel estimations as nearly in the same way as practical. However, with crystallized ferric ammonium sulphate (ferric ammonium alum) I was able to get very satisfactory results both as to consistency and accuracy, the results comparing favorably with those obtained by the hydrogen gas method, the time being approximately 15 min. instead of from 6 to 36 hr., the approximate time limits for the gas method. The process is satisfactory when 1 g. of zinc dust is weighed into a 600 cc. Erlenmeyer flask and 50 g. of the ferric ammonium alum in crystals (the larger the better) and 100 cc. of water added. The mixture should be kept in constant stirring motion by giving a suitable motion to the flask. The crystals of ferric alum aid in stirring the zinc dust and will usually not all be in solution when the zinc dust is dissolved. As soon as the zinc dust is all dissolved add 100 cc. of 1 to 10 sulphuric acid and titrate with N/10 potassium permanganate solution. In case there are many analyses to be made it saves calculation to use a potassium permanganate solution each cubic centimeter of which represents 1 per cent of zinc on a 1 g. sample.

COMPARISON OF RESULTS BY DIFFERENT METHODS

The results are quite accurate enough for the estimation of the metallic zinc content of used or unused zinc dust in sherardizing plants. The following analyses of used and unused zinc dust by the hydrogen gas method and the ferric ammonium alum method were made from the same sample in each case and show a very close comparison:

NEW ZINC DUST

Hydrogen Gas Method	Per Cent	Ferric Alum Method	Per Cent
No. 1	94.9	No. 1	94.7
No. 2	94.9	No. 2	94.7
No. 3	94.8	No. 3	94.6
No. 4	95.1	No. 4	94.5
No. 5	95.3	No. 5	94.6
Average	95.0	Average	94.8

USED ZINC DUST

Hydrogen Gas Method	Per Cent	Ferric Alum Method	Per Cent
No. 1	79.4	No. 1	79.7
No. 2	78.8	No. 2	79.6
No. 3	78.6	No. 3	79.7
No. 4	79.5	No. 4	79.8
No. 5	78.4	No. 5	79.8
Average	78.9	Average	79.7

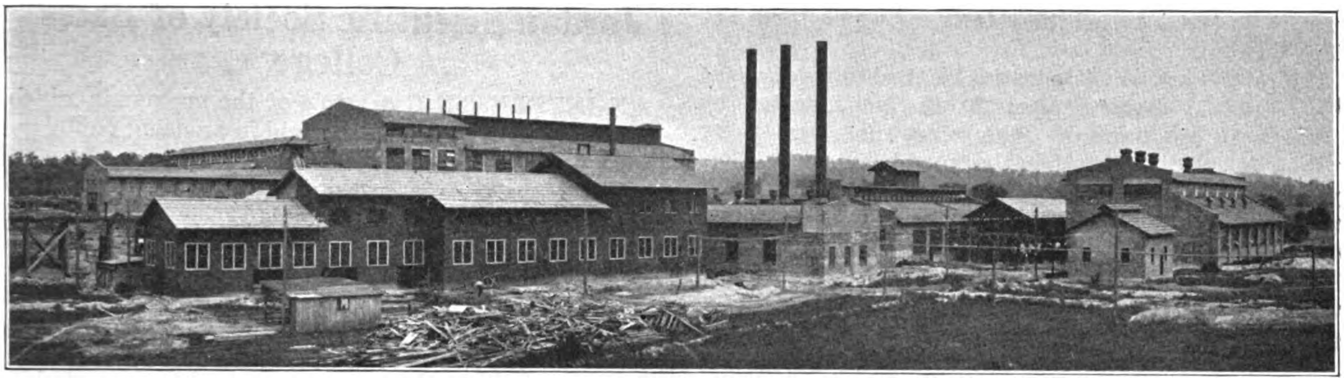
In the case of the hydrogen gas method on used zinc dust I was unable to get a completed reaction in less than 24 hr., the time being more often 36 hours. Attempts to speed up this method by using stronger acid than usual led to freak speeds that gave unsatisfactory results. I have not made any attempt to explain the freaks.

On the whole I think I am justified in stating that the ferric ammonium alum method of estimating the metallic zinc content of both used and unused zinc dust is quite satisfactory for all practical purposes.

Civil Service Examinations

Metallurgist.—A vacancy in the Bureau of Mines, Pittsburgh, Pa., at $2700 a year will be filled from this examination. In addition to a college degree, the applicant must have had four years' experience in metallurgy, at least two years of which must have been in aluminum and magnesium foundry and rolling practice. Applications must be filed by Aug. 26, 1919.

Research Chemist.—The duties of this position include research chemical work in connection with iron, steel and associated alloys or refractories and gases, as assignments will be made in the Ordnance Department at Large, War Department, for duty at ordnance establishments throughout the United States, at a salary of $2200-$2500. Examination closes Sept. 2, 1919.



PLANT OF KINGSPORT WOOD REDUCTION CO., KINGSPORT, TENNESSEE

A New Method of Distilling Both Green and Seasoned Hardwoods

OUR readers are more or less familiar with the Government's urgent need for large quantities of chemicals in its warfare activities. However, some of us may not have realized the extreme importance of acetone and acetates in our aircraft production program, these being essential ingredients in the dope applied to aëroplane fabrics.

The Government's requirements so far exceeded the nation's possible production from the available supply of dry or seasoned woods that the authorities welcomed a new process which would procure these and other products from green wood, sawdust or wood-waste quite as well as from seasoned cordwood. It takes about twelve months properly to season cordwood preparatory to destructive distillation by what we may now term the old line process.

The new process has for its chief points of advantage a method of briquetting sawdust or finely divided wood-waste and of distilling the wood briquets under controlled conditions of temperature and pressure in multitubular retorts.

The briquetting machines, the invention[1] of Mr. Otho C. Duryea, have been in use for about three years briquetting brass and copper borings and turnings at plants located at Waterbury, Conn., and Chicago.

The material is compressed in a specially designed press. One of the plungers of this press is driven against the compressed charge by the explosion of a gas-mixture in an auxiliary cylinder. The resultant impact produces the briquet.

Tests were made to satisfy the Government that sawdust, or "hogged" and shredded wood, could be similarly briquetted, after drying; that the supplementary processes of shredding, distillation in multitubular retorts, the recovery of pyroligneous acid and its constituents, wood alcohol and acetate of lime, were thoroughly practical on a large scale.

The Kingsport Wood Reduction Company contracted to erect and operate a plant using this process, the only one of its kind in the world. Accordingly a 35-acre site was selected near the city of Kingsport, Tennessee, in in the mountains about equidistant from the Virginia and North Carolina boundaries. This location was chosen because it tapped an area in which a valuable supply of hardwood sawdust was available from the scores of mountain saw mills in the three adjoining States, also because of the large available supply of standing hardwood timber. The timber belt upon which the plant depends for its current supplies extends for more than one hundred miles in every direction.

Ground was broken in April, 1918. Buildings and equipment costing over a million dollars were rushed toward completion with such vigor that the armistice of the following November found the plant practically ready to make initial deliveries.

HANDLING THE RAW MATERIAL

Trainloads of sawdust and wood-waste are received on an elevated trestle in drop-bottom cars, the cars being emptied into bins alongside the process building. The sawdust and fine material is carried by a conveyor direct to rotary screens located in the process building. The cordwood, either green or dry, together with slabs and other coarse wood-waste, is carried by conveyer into two "hogging" machines in the same building, where it is "hogged" and shredded prior to being briquetted. Both the sawdust and shredded wood pass through cylindrical screens and from these to special patented rotary driers by means of conveyor system. The driers are about 8 ft. in diameter and 60 ft. long and are heated by coal. Their operation is so flexible and efficient that however wet the entering sawdust may be the product emerges as a steady stream in a completely dried condition.

BRIQUETTING THE PROCESSED WOOD

From the rotary driers an automatic conveyor carries the dried sawdust and shredded wood up an incline into eight storage bins in the top of the press building. In this building is located a battery of eight briquetting presses, one for each storage bin.

The material feeds by gravity from each bin into a high-speed rotary shutter, which fills the briquet mold. Every two seconds the horizontal plungers of each of these machines move inward toward each other and when the eighteen inches of sawdust are compressed into a space of about five inches, the explosion takes place and the resultant shock, aggregating many tons to the square inch, impacts the material into a briquet two inches thick and four inches in diameter. The wood briquet weighs approximately one pound and is heavier than water.

DISTILLING THE WOOD BRIQUETS

As the briquets are discharged from the presses, they roll down through chutes into a storage bin at one end of the adjoining retort building. Here a novel assembling device sets them on edge, like lozenges in a package, in angle-iron troughs 20 ft. long. The filled troughs are lifted onto a charging car, which is moved forward to the doors of the retorts, of which there are 26 in this building.

---

[1] U. S. Patent, 1,220,783.

The retorts are a multiplication of steel tubes of about 5 in. internal diameter and 20 ft. long, heated by a battery of gas burners. The retort tubes are larger in their inside diameter than the wood briquets, to allow space for the escape of the gases and the heavier liquid products. As the charging car is brought in alignment with a retort, the front and rear retort heads are raised and a mechanical pusher shoves the briquets into the tubes, forcing the red-hot charcoal of the previous heat out at the other end of the tube.

A heat takes about two and one-half hours. The temperature is under such accurate control as to drive off each distillate at the temperature most favorable for both quantity and quality production. During the heat, hydraulic compression plungers exert a pressure against the charge of now plastic briquets. This control of the compression of the charge, together with the accurate control of heat, produces a charcoal of such density and uniformity that its power for absorbing gases has been hitherto unequalled. As the process developed, it was discovered that the tars and oils and their products take on equally unusual characteristics, which, it is claimed, will give them distinctive commercial value.

Recovering the Distillation Products

The gaseous product, pyroligneous acid, passes through copper piping from the condensers to the stills, while the tar is piped to the tar stills. Subsequent distillation of the pyroligneous acid produces acetic acid, wood alcohol, oil and tar residues.

The alcohol is pumped from the still house into two large steel storage tanks. The acetic acid is drawn off into mixing tubs, where it is combined with calcium oxide to form acetate of lime. Drum driers revolving in these tubs pick up a film of the solids, which are scraped off by a steel knife and deposited on a horizontal belt conveyer. This conveyer, in turn, delivers the pasty product to a broad endless drier belt formed of interwoven steel links which become covered and enmeshed with the plastic material. Drying is accomplished during the passage of this belt upward and downward through a series of gas heated tile flues extending from floor to ceiling of the tall building. The acetate of lime is thus baked onto the chain belt, and at the end of its travel it encounters a series of sharp turns which crack the caked acetate off the chain and deposit it in granular forms on a movable conveyer. It is then sacked and delivered by a chain conveyer directly into freight cars.

Refining the Tar

The tar from the retorts is carried directly to the tar stills, where it is refined and the creosote, oils, pitch and other wood-tar products are recovered. Provision has been made for enlarging and extending the tar distillation and refining facilities of the plant to meet the requirements of the various markets that may develop.

The plant as it now stands has a capacity for handling one hundred cords of hardwood per day, or its equivalent in sawdust and wood-waste. This is approximately two hundred tons of dry wood or from three hundred to four hundred tons of green or wet wood. With the cessation of hostilities the Government's demand for these essential products ended, but arrangements are being perfected for the operation of the plant along commercial lines by its builders.

Jordan Scientific Society of Bates College

AN INTERESTING example of the manner in which student organizations can aid in arousing public interest in scientific developments—particularly those of applied science—is afforded by the activities of the Jordan Scientific Society of Bates College at Lewiston, Me.

In 1918 an exhibition of some of the work done by members of the society was held, primarily for the purpose of interesting nearby high-school students in the college. The first exhibit proved such a success that this year the scope was increased to include local business men and the general public.

Every course offered in chemistry at Bates was represented by an exhibit with work being done by students just as it is done in the laboratories. Thus in general chemistry students prepared nitric acid, while in industrial chemistry various commercial analyses were carried out. In the advanced organic preparations several dyes manufactured in the college laboratories were shown. Lewiston is a thriving textile center with ten cotton and woolen mills, hence work in textile chemistry was featured at the exhibit, and more than one mill agent made favorable comment on this feature. National manufacturers have co-operated with the department of chemistry by sending permanent exhibits of their products and the raw materials entering into their manufacture until the department has over forty exhibits illustrating most of the important chemical industries. These were placed on exhibit with proper placards and formed one of the most interesting parts of the exhibit to the general public. In fact this exhibit was somewhat of a miniature reproduction of the National Chemical Exposition.

The programs of the society meetings were made more interesting by the use of moving pictures to illustrate papers. Films were obtained through co-operation with the Bureau of Commercial Economics and national manufacturers and included such subjects as "Operation of a By-Product Coke Oven," "Operation of a Pulp and Paper Mill," "Refining of Sugar," "Cyanamide Process," and "Cottrell Precipitation." In addition to papers explaining these processes, other members have given original papers on "Synthetic Rubber and Rubber Substitutes," "Dehydrated Foods," "Radium Emanations," "Use of the Spectroscope and Spectrometer in Spectrum Analysis," with plates prepared in the Bates laboratories; "Gas Warfare," and "The Fourth Dimension."

The Society was exceedingly fortunate in securing for one of its speakers Dr. H. E. Williams, research chemist with the S. D. Warren Paper Co. Dr. Williams spoke on "Black Liquor" and showed some of the products which he had been able to recover from it. Dr. Williams has the distinction of being one of the few men in the United States who is an authority on this phase of the paper industry.

This short sketch of the activities of the Jordan Scientific Society is given with the hope that some other college may find them as worth while as they have proved at Bates. Many of the large Western colleges are using moving pictures to good advantage; so far as is known, Bates is one of the few Eastern colleges to use films. The idea of an exhibit by a student organization of a college is believed to be original, but capable of great development.

Alignment Chart for the Gas Laws

By Alan G. Wikoff

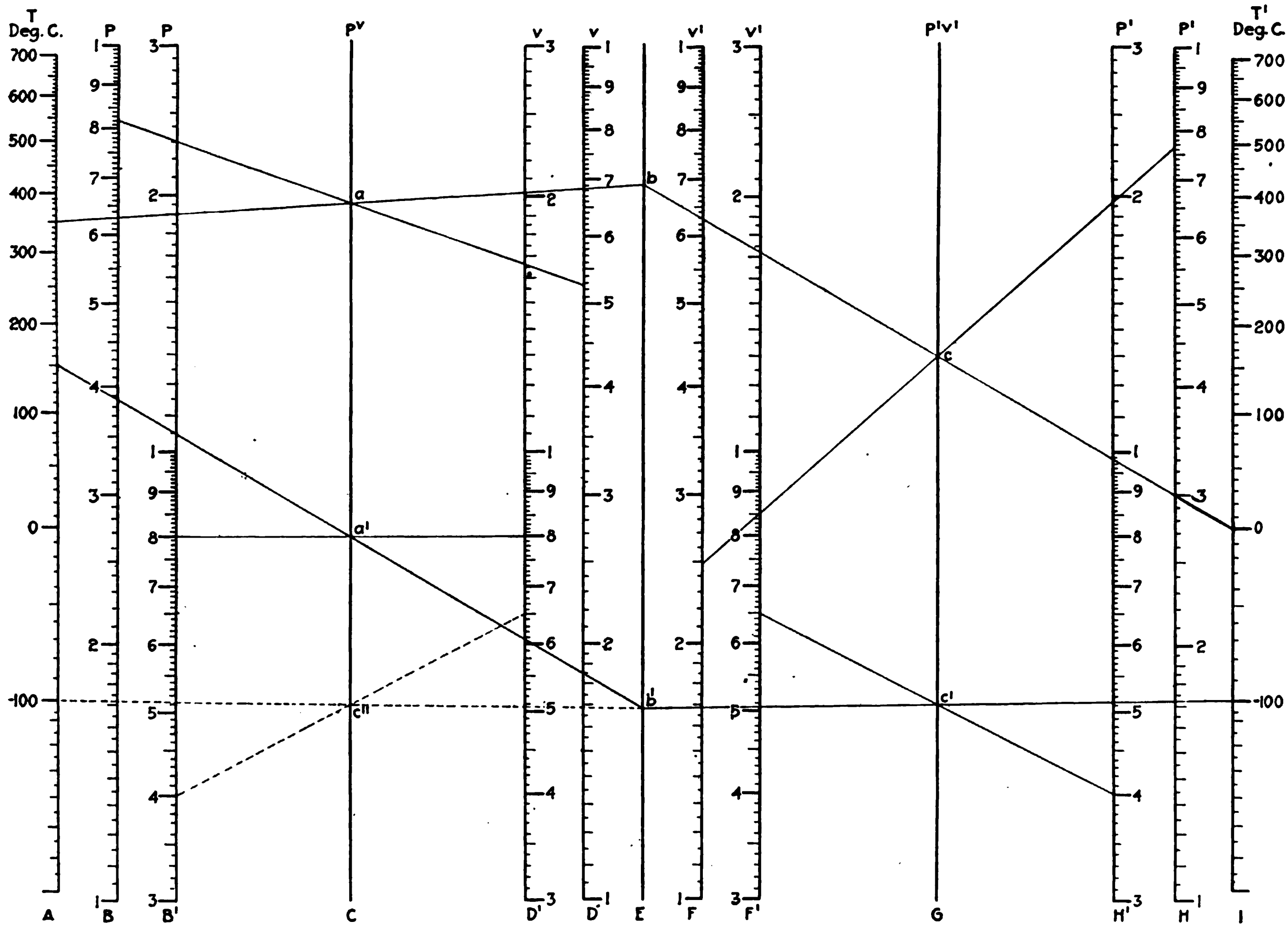
While the Boyle-Mariotte-Charles law, $pv = RT$. is applicable with a high degree of accuracy only to the permanent gases at pressures below three atmospheres, the relation

$$\frac{pv}{T} = \frac{p'v'}{T'}$$

which is derived from this law, is constantly employed in practical work for the calculation of gas volume under different conditions of temperature and pressure. In the accompanying alignment chart for the solution of this equation, the necessity of converting deg. C. into deg. absolute is avoided by graduating the temperature scales A and I so that the scale reading in deg. C. corresponds to the logarithm of the absolute temperature.

There are two pairs of p, v and p', v' scales, one pair having the index at the bottom of the chart, the other near the center. The advantage of such a construction is evident when we consider the actual operation of the chart. Let the unknown be p', v' or T', all the other values being known. Starting with p, v and T, the product, pv, is first obtained by joining the numerical values of p on scale B and v on scale D by a straight line, giving a point of intersection on C. Since we are not interested in the numerical value of this product, this scale is not graduated. If this point on C is now connected with the value of T on A, we obtain a point on E which represents the quotient, $pv \div T$. Here again, the numerical value is not required. If T' is known, connect the value of T' on scale I with the point on E and obtain a point of intersection on G, which, aligned with the value of v' or p' (whichever is known) on F or H, gives the unknown on either H or F. If T' is unknown, first obtain the point $p'v'$ on G and align this with the point on E, giving the value of T' on I. If, when using scales B and D for p and v, the point $pv \div T$ does not fall within the limits of the chart on E, the values of p and v should be transferred to scales B' and D' and the corresponding pair F', H' used for v' and p'. (See example II below.)

Since the chart is symmetrical about E, all of the operations may be carried out on one side, as shown in example IIA. The extended form is given, however, in order that the principle may be more readily grasped.



Example I: Given 525 cc. of oxygen at 820 mm. and 350 deg. C.; what is the volume under standard conditions (760 mm. and 0 deg. C.)?

v = 525 cc. v' = x
p = 820 mm. p' = 760 mm.
T = 350 deg. C. T' = 0 deg. C.

pv: Align 820 on B with 525 on D; obtain point a on C.
$pv \div T$: Align 350 on A with a; obtain point b on E.
$(pv \div T)\ T'$: Align 0 on I with b; obtain point c on G.
$(pv \div T)\ (T' \div p')$: Align 760 on H with c; obtain x = 248 on F.

Example II: Given 8 liters of a gas at 80 cm. and 150 deg C.; at what temperature would the volume be 6.5 liters when the pressure had been reduced to 40 cm.?

v = 8 l v' = 6.5 l.
p = 80 cm. p' = 40 cm.
T = 150 deg. C. T' = x

pv: Align 8 on B' with 80 on D'; obtain point a' on C.
$pv \div T$: Align 150 on A with a'; obtain point b' on E.
$p'v'$: Align 6.5 on F' with 40 on H'; obtain point c' on G.
$p'v' \div (pv \div T)$: Align b' with c'; obtain x = —100 on I.

Example IIA: Same problem as Ex. II showing method of solution, using only one side of the chart.

Obtain b' as above.
$p'v'$: Align 6.5 on D' with 40 on B'; obtain point c'' on C.
$p'v' \div (pv \div T)$: Align b' with c''; obtain x = —100 on A.

Uses of Manganese Dioxide Ore*

BY W. C. PHALEN

ESTIMATES of the quantity of manganese ore used in the industries other than the metallurgical industries vary from 25,000 to 50,000 tons per annum. The latter figure is probably more nearly correct. Most of the ore so used is the highest grade of pyrolusite (MnO_2) obtainable and commands a much higher price than metallurgical ore. The manganese dioxide ore is generally spoken of as chemical manganese ore.

The principal use of manganese ore aside from its applications in the steel industry in the form of ferromanganese and spiegeleisen is as an oxidizing agent. It is so used principally in the manufacture of dry cells, as a decolorizer in certain kinds of glass, and as a drier in oils, paints and varnishes. The ore is also used directly or indirectly in the manufacture of various manganese chemicals. Many of the textbooks describe its reaction with hydrochloric acid as a source of chlorine. It is no longer used commercially in making chlorine gas, as the latter is an abundant by-product in the manufacture of caustic soda and potash. Some chlorine may be made by this method when the object is the production, not of chlorine, but of manganese chloride. It has been mentioned as a soil stimulant, but its value in the fertilizer industry has not been established and so far as known it is not a constituent of any commercial fertilizers. Only those uses of commercial importance will be mentioned here.

The Dry Cell

GENERAL DESCRIPTION

To understand fully the rôle played by manganese dioxide in the dry cell, it will be necessary to explain the general make-up of the cell, the chemistry of the processes involved, together with the constituents entering into the reactions.

The modern dry cell, commonly but erroneously called the dry battery, is a portable modification of the "Disque" Leclanché cell invented by Leclanché about 1868. This consisted of a porous cup containing a carbon electrode and a mixture of rather coarsely ground retort coke and pyrolusite. The cup was sealed over, two vents being left for the escape of excess gases, and was placed along with a zinc rod in a glass jar containing a solution of ammonium chloride. Because of its simplicity and ease of operation, many attempts were made to fix the electrolyte in various media such as sawdust, gelatin, asbestos and silicic acid, so as to make it portable.

In 1888 Gassner brought out the first really successful dry cell. The positive pole consisted of a cylindrical mass of ground pyrolusite and coke packed in a canvas bag around a carbon electrode. This was placed in a zinc container which also served as the negative pole, and a paste of plaster of paris, zinc chloride and ammonium chloride was poured under and around it. After a short time, the paste would set and then the cell was sealed with a rosin or pitch composition.

The Gassner cell, though a great improvement over various other dry cells of the time, did not meet with much favor because of its high internal resistance and low voltage. The highest current that could be obtained was about 6 amp., and its voltage was about 1.3. Because of these facts, its use was limited to service requiring only small current drains.

DEVELOPMENT

The advent of the gasoline engine gave the development and production of the present type of dry cell a great stimulus. Its use in ignition systems demanded a cheap portable cell able to recuperate after comparatively heavy current drains. In 1897 its manufacture attained considerable volume. The present normal yearly requirements of this production include about 25,000 tons of high-grade manganese dioxide ore, an equal amount of carbon (petroleum coke and graphite) and 8,000 to 10,000 tons of sheet zinc together with corresponding quantities of zinc chloride, ammonium chloride, paper, carbon electrodes, pitch and sundry other substances.

METHOD OF MANUFACTURE

In the modern American dry cell of the usual type, the negative pole consists of a cylindrical zinc can which also serves the purpose of a container. Several sizes are on the market, the great majority, however, being about 2½ in. in diameter by 6 in. high, (the so-called No. 6 cell). The inner surface of the zinc is lined with a special grade of absorbent paper, acting as a reservoir for the electrolyte, and has a diaphragm between the zinc and the positive pole. The depolarizing mass, called the "mix," is tightly tamped into the can around a centrally located carbon electrode to about 1 in. from the top. This "mix" is composed of ground carbon, usually calcined petroleum coke and graphite, manganese dioxide ore and the electrolyte. It, together with the carbon electrode, is the positive pole. After the mix has been tamped, the paper is turned down over the mix; sand or sawdust is poured in, to a depth of about ½ in. and the cell is sealed with a hot pitch composition. The object of the layer of sand is to provide an expansion chamber for the electrolyte and the excess gas, and also to provide a dry bed for the hot pitch.

CONSTITUENTS USED

The zinc sheets used for the cans are substantially pure, prime Western spelter being generally used. The sheets are usually about 0.016 to 0.019 in. thick in the 2½ by 6 in. cells. Comparatively little of the zinc is used up during the service life of a cell. The mechanical strength to withstand filling and the fact that the can corrodes unevenly, in spots, patches or streaks, must be taken into account when considering the necessary thickness. One of the problems of the dry cell manufacturer is to construct the cell so as to make this corrosion uniform.

Most manufacturers at the present time use a special grade of pulp board for lining the cans. Blotting paper was formerly largely used, but is now employed in only few brands. The paper now generally used consists only of ground wood pulp and sulphite pulp, and is 0.03 to 0.04 in. thick. It should be porous enough to allow the electrolyte to diffuse readily through it, but still retain the smallest particles of carbon and manganese; and it should be capable of absorbing several times its weight in water. Furthermore, it should obviously be free from metallic particles.

The depolarizing mass or "mix" is the vital part of the cell. Its different components must be suitably proportioned to render the most efficient service. They, together with their different functions, will be discussed in turn.

---

*Part of a comprehensive bulletin on manganese that is to be issued by the Bureau of Mines.

The ammonium chloride should be equal in purity to the usual chemically pure article. It should be substantially free from alkalis, sulphates, inert material and heavy metals. When the cell is discharging, by virtue of the carbon, manganese dioxide, and zinc couple, the ammonium chloride is split up into hydrogen, ammonia, and chlorine, which attacks the zinc can, forming zinc chloride. The reaction is:

$$Zn + 2NH_4Cl = ZnCl_2 + 2NH_3 + H_2$$

The liberated gases are the cause of polarization and will be discussed further, under zinc chloride and manganese.

The graphite used is generally of the artificial variety, several grades of which are prepared for use in dry cells. It does not enter into the chemistry of the cell, serving only with the coke to render the mix more conductive. The coke used is calcined petroleum coke, that is, residues remaining in petroleum stills. When raw, it is practically a non-conductor. However, on being calcined at a high temperature it becomes denser and as good a conductor as the better grades of amorphous natural graphite.

The relative fineness of the graphite, coke and manganese ore, together with their distribution, should be so uniform as to make the mix approach a solid porous mass. The current should flow along radial lines from the carbon electrode to every point on the surface of the mix adjacent to the paper lining. The ideal condition is to have each particle of manganese covered with a coating of carbon sufficient to render it a good conductor, but still porous enough to permit efficient depolarization, while the voids should be filled with the porous coke.

The zinc chloride should be of good grade, as free as possible from heavy metals. Its function is to depolarize the ammonia, which it does by the formation of double salts of zinc and ammonium chloride. No exact information is available as to the reactions involved, but it appears that a slightly soluble double chloride of zinc and ammonium is formed as the end product. During the earlier part of the service life of a cell, inefficient depolarization of the ammonia is probably often the cause of its failure under heavy drains. A cell that has been short-circuited or subjected to a heavy drain smells strongly ammoniacal when opened. Another cause of dry-cell failure is the formation of a highly resistant, non-porous crust between the paper lining and the zinc can, owing probably to the formation of the double salt mentioned above or the formation of zinc hydrate.

RÔLE OF MANGANESE

The function of the manganese is to depolarize the hydrogen. The reaction involved is usually given as follows:

$$H_2 + 2MnO_2 = Mn_2O_3 + H_2O.$$

It has been shown that the manganese reacts almost instantaneously in depolarizing the hydrogen, very likely while the latter is still nascent.

CHARACTER OF MANGANESE ORE USED[1]

Chemical Requirements. There are several factors entering into the suitability of manganese ore for dry cells. It should have a high available oxygen content present in the form of pyrolusite (MnO_2), and a minimum amount of iron and should be free from copper, nickel, cobalt, arsenic, and other metals electronegative to zinc. Copper in particular is very harmful. If these impurities are present in the form of compounds insoluble in the electrolyte, they do no harm, other than being inert or poor conducting materials. If soluble, however, their solutions diffuse to the zinc can, where they are deposited, forming an electrocouple which results in local and useless corrosion of the zinc and consequent deterioration of the cell. When the cell is in service, the deterious action of these impurities is greatly hastened.

Physical Requirements. The physical properties of manganese ores also influence their suitability for use in the dry cell. It is generally conceded that an ore should be somewhat porous to perform its function efficiently. A somewhat hard but porous ore is likely to give better results than a hard, dense ore, even though the latter is higher in available oxygen. In a dense ore, the depolarizing reaction takes place only on the surface, while in a porous ore it is able to occur throughout the mass. Better service life is obtained from a dry cell containing rather coarsely ground ore which is able to hold more electrolyte than finely ground ore. Other factors of importance are the porosity of the ore and the fact that more contact resistance exists between the particles of fine ore than those of coarse ore. It has also been demonstrated that careful grading of the ore greatly influences the performance of a cell. The ore, therefore, should not be of an earthy nature like wad, as this mineral does not lend itself to efficient milling and grading.

Prior to the war, the manganese ore used in dry cell manufacture was Caucasian pyrolusite. The common method of specification was for material containing from 80 to 85 per cent MnO_2 and less than 1 per cent iron. No particular attention was given to other ingredients, at least by most buyers, because of the purity and uniformity of the Caucasian ore. There are considerations other than the content of MnO_2 which determine the usefulness of manganese for depolarizer purposes, such as the screen analysis, hardness, density and other physical qualities. Various manufacturers employ different specifications as to the screen analysis, a common specification being that the run of material shall pass through a 10-mesh or a 20-mesh screen. Some manufacturers specify the removal of the fine particles.

During the war manganese from many other sources was used in the dry-cell trade owing to the scarcity of the Caucasian material. Most of these ores run lower in MnO_2 and higher in iron and they have larger percentages of impurities, some of which are decidedly harmful. During the war, users accepted material that ran from 70 to 80 per cent MnO_2 and as high as 3 to 4 per cent in iron. Users have found by experimental work and manipulation how to get results with domestic ores and with foreign ores other than Caucasian, closely approximating the results secured from Caucasian material.

An important source of manganese dioxide during the period of great scarcity during the war was the ore obtained from old dry cells, which was rejuvenated by processes generally kept secret by the firms employing them. Such processes doubtless contributed in an important degree to the conservation of our high-grade domestic manganese ore.

---

[1] Storey, O. W., "Determination of Manganese Dioxide in Pyrolusite." C. F. Burgess Laboratories, Madison, Wis.

In the manufacture of dry cells, two classes may be recognized—the standard or so-called No. 6 cell, which is used for ignition, telephone, signal and other similar purposes; and the small-size, or flashlight type, which is used for portable lighting. The quantity of pyrolusite ores used in the standard No. 6 cell is far larger than that used in other sizes. In the flashlight business, which is growing with great rapidity, the higher grades of materials are required, such as 80 to 85 per cent ore which has been purified and also various grades of chemically prepared manganese dioxide and hydrates of the same.

Manganese Ore in the Ceramic Industries

USE IN MAKING GLASS

Practically all the raw materials used in glass contain some iron, usually in the form of ferric oxide. The iron, when present even in small quantity, imparts to the glass a pale green color which increases rapidly in intensity as the iron content increases. If a colorless glass is desired, this green color must be removed, removal being effected by the use of various decolorizers. Manganese, selenium, cobalt and nickel are the most common decolorizers in use, and of these four, manganese has been most commonly employed because it permits easy control of the color. In using selenium and nickel, the quantity must be carefully controlled, but these latter substances are desirable, especially in window and plate glass, because glass decolorized with manganese often changes to a pink color on exposure to the light. A decreasing quantity of manganese is being used by makers of tank glass, and its place is being taken by selenium.

The quantity of manganese used varies considerably, depending on the character of the glass, the method of its manufacture, the iron content of the raw materials and the character of the manganese ore used. Each manufacturer has his own ideas on this subject and he puts these into practice within certain limitations. The quantity used is figured in terms of pounds of manganese dioxide per 1000 lb. of sand, which constitutes 50 to 75 per cent by weight of the entire batch. The temperature employed in the glass-making process is also a factor determining the quantity of manganese dioxide used; the higher the temperature employed, the more manganese is necessary owing to the volatilization. The maximum limit is 10 to 15 lb. of manganese dioxide per 1000 lb. of sand, from which it may range to as low as 2 to 2½ lb. of manganese dioxide.

CHEMISTRY OF USE OF MANGANESE IN GLASS MAKING PROCESS

The compounds of manganese, when other coloring ingredients are absent, produce pink, purple and violet hues according to the chemical nature of the glass. The presence of manganese dioxide neutralizes the green color due to the presence of iron compounds in the raw materials. Used in excess, it imparts an amethyst tint, and when used in considerable excess, the color is so intense as to appear black.

The neutralization of the iron tint by manganese dioxide is explained by some chemists on physical grounds, and by others on a purely chemical basis. The green tint is due to the presence of ferrous silicate. It is thought by some that this green compound is oxidized to the ferric silicate, the color of which is an almost imperceptible pale straw yellow. According to this view, the oxidizing agent used must not completely decompose at high temperatures, and manganese dioxide appears to be the most available compound fulfilling this condition. At red heat, the dioxide loses one-third of its oxygen, leaving the tetra-oxide (Mn_3O_4) which, at still higher temperatures, is an oxidizing agent.

Red lead and other oxidizing agents have not this decolorizing power, which has given basis to the thought that the result is not due to oxidation, or chemical reaction, but that the phenomenon is purely physical in its nature. It is possible, however, that other compounds may lose their oxygen at too low temperatures to be effective as oxidizing agents.

SPECIFICATIONS FOR MANGANESE ORE USED IN MAKING GLASS

Before the war, the ordinary specifications for manganese ore used in glass making were 85 to 90 per cent manganese dioxide and less than 1 per cent metallic iron. Outside of these two ingredients, each manufacturer has his own peculiar requirements. Special glasses may require a grade of ore carrying more than 90 per cent manganese dioxide and less than 0.5 per cent iron. The higher the manganese content and the lower the iron, the better the material for glass-making purposes. In general, the grades of ore used in this industry are similar to the grades used in the dry cell industry. Obviously, siliceous pyrolusite is not objectionable, but carbonaceous pyrolusite is.

The manganese ore for use in glass is sold in powdered, granulated or lump form. There are certain objections to the lump form, owing to the time required to melt it into the batch. The powdered ore is used principally where the glass is made in pots. The lump ore, or granular, is used when melting is done in tanks.

Before the war, high-grade pyrolusite for glass making and other chemical purposes was imported from Russia, Saxony, Japan, Nova Scotia, and other foreign countries. As the war progressed, it became difficult to obtain foreign high-grade ore and, as a consequence, specifications were relaxed and low-grade ores were offered and purchased. During the war period some excellent domestic ore was developed, which found a ready market.

OTHER CERAMIC USES

Another use for manganese ore in the glass-making industry has developed in the last few years, namely, in the production of black glass used for ornamental purposes. About 3 per cent of ore is added to the batch in making this opaque glass. Pyrolusite is also added to the constituents of glazes and enamels to produce purple tints. Black enamels are those containing manganese. Manganese oxide is also used in brick making.

Use of Manganese Salts in Driers

Definition. Driers are those substances, generally metallic oxides or their compounds, which are added to linseed or other drying oils at high or low temperatures to make them capable of readily absorbing oxygen from the air, or of drying by its action. The action is considered by some chemists to be catalytic, the manganese compound acting as a catalyzer or carrier of oxygen. The principal manganese compounds used as driers are: Manganese sesquioxide (Mn_2O_3), pyrolusite (MnO_2), also known in the trade as dioxide, binoxide or peroxide, manganese hydrate, sulphate, borate, resinate, linoleate, oxalate and possibly other salts. Certain corresponding double salts of manganese and lead are often used.

Some persons claim that pyrolusite is now little used in driers because the manufactured hydrate, on account of its purity, gives better results. This claim does not agree with statements made by dealers in the trade. Of the various substances named above, each acts in a way peculiar to itself. These driers are added only in small quantities, usually less than 0.5 per cent.

Manganese Dioxide. Manganese dioxide is extensively used as a drier. It comes onto the market in two forms, the natural and artificial. The natural mineral, pyrolusite, is simply ground to a powder with water and then dried. The mineral is essentially a peroxide, a class of substances containing more oxygen than is required to satisfy the valence of the metal present. This extra oxygen is loosely combined and readily enters into combination with oxidizable bodies. This feature in the composition of manganese compounds makes them useful in oil boiling, for the oxygen during this process combines with the oil, oxidizing it, while the manganese dissolves to some extent in the oil in the form of a compound with the linoleic acid of the oil. In consequence of this action manganese compounds are powerful driers. The quantity of manganese dioxide added in the process of boiling is small, not more than ½ lb. to a hundredweight of oil to get the best results. The use of the black dioxide, however, tends to make the oil dark.

Manganese Sulphate. The methods of preparing this compound and its uses are described later. Rather less than ½ lb. is added to each hundredweight of oil or paint. It is largely used by oil boilers as a drier of pale boiled oils.

Manganese Borate. Manganese borate is perhaps the least objectionable of all the manganese salts used as drying agents, though the black oxides are more largely used. To make the borate, 1 part of manganese sulphate is dissolved in 10 parts of distilled water and a little of this is added to some soda solution to determine whether any iron is present. If pure, the manganese sulphate solution is added to the hot borax solution as long as a precipitate forms. The precipitate is filtered, washed with hot water, and dried.

Manganese Resinate. Resinates, formed by the combination of resin or rosin with certain metallic oxides, occupy a prominent position in modern varnish and paint making and with the exception of the linoleates are most readily soluble in linseed oil. The manganese resinate is made as follows: Soda ash is dissolved in water and the solution is boiled with steam, and light coarsely powdered rosin is added. After the proper quantity of rosin has been added, more soda ash is added. The clear solution is allowed to run into a clear manganese chloride, the resinate separating as a white flocculent precipitate. This is filtered, washed and dried.

Manganese Linoleate. This is made by pouring a solution of a soap, made by boiling linseed oil and caustic soda, into a solution of manganese chloride or manganese sulphate. It forms a dark-brown plaster-like mass, liable to oxidation. When exposed to air, the surface becomes covered with a hard rather insoluble protective skin. The material should, therefore, be kept in tightly closed vessels. It acts both as a bleaching agent and a drier on linseed oil. One pound mixed first with 5 lb. of linseed oil and the whole poured into 10 gal. of linseed oil at 250 deg. F. gives a good drying oil.

Manganese Oxalate. This salt is prepared by precipitating manganese salts with oxalate of soda or potash or by treating manganese hydrate or carbonate with oxalic acid. One of its advantages is said to be that during the process of oil boiling it is decomposed, the manganese dissolving in the oil in combination with linoleic acid, while the oxalic acid is decomposed and evolved in the form of carbonic acid. One-fourth to one-half a pound may be used per hundredweight of oil.

Use of Manganese in Miscellaneous Chemicals

Manganese Chloride. Manganese chloride ($MnCl_2$) is prepared by the action of hydrochloric acid on the dioxide. Chlorine is a by-product of this reaction. It is a rose red, deliquescent salt used in dyeing cotton cloth a manganese brown or bronze. The fabric to be dyed is soaked in the salt solution and passed through a caustic alkali, whereby manganese hydroxide is precipitated in the fabric and on subsequent oxidation, turns brown. The material thus treated may also be used for subsequent dyeing by aniline black.

Manganese Sulphate. This salt ($MnSO_4$) may be prepared on a large scale from the black dioxide by heating to redness with ferrous sulphate and by subsequent extraction with water. It forms pink crystals which are readily soluble in water and are used in calico printing and in porcelain painting. It is also used at drier for pale oils or for conversion into the oxalate or borate which are used for the same purpose.

Manganese Persulphate. This salt, $Mn(SO_4)_2$, is prepared by the electrolytic oxidation of manganous sulphate ($MnSO_4$) and forms a black substance which can only be obtained in solution in the presence of sulphuric acid. It has marked oxidizing properties and is used as an oxidizing agent in making organic products.

Potassium Permanganate. This substance ($KMnO_4$) is prepared industrially by mixing a solution of caustic potash (KOH), specific gravity 1.44, with powdered manganese dioxide and an oxidizing agent like potassium chlorate. The whole is boiled and evaporated, and the residue is fused in crucibles and heated until it acquires a pasty consistency. The potassium manganate (K_2MnO_4) thus obtained is dissolved by boiling with much water while a current of chlorine, carbon dioxide or ozone is passed through the liquid. The potassium permanganate separates in crystalline form from concentrated solutions even in the presence of the caustic potash formed during the reaction, and is separated from the dissolved substances in a hydro-extractor.

The permanganate is used for conserving wood; it is also used for bleaching textile fibers, by immersing them for a time in an aqueous solution of the permanganate and then dissolving the manganese dioxide with sodium bisulphite. The permanganate is an energetic disinfecting and oxidizing agent and is used for purifying various gases.

Chemical Glassware

The manufacturers of chemical glassware in this country fear that the importation of the Japanese laboratory glassware will greatly endanger the American industry. It is claimed that labor alone costs in this country nearly equal the selling price of the Japanese goods. A committee of chemical glassware and porcelain manufacturers has urged the Ways and Means Committee of Congress to levy a 60 per cent *ad valorem* tariff on imports.

Exports and Imports

The Bureau of Foreign and Domestic Commerce of the U. S. Department of Commerce reports for May, 1919:

DOMESTIC EXPORTS OF CAUSTIC SODA AND SODA ASH FROM U. S.

Countries	Caustic Soda Lb.	Caustic Soda Value	Soda Ash Lb.	Soda Ash Value
Denmark	113,270	$5,520	....	....
France	400	120	....	....
Greece	217,597	6,498	....	....
Iceland and Faroe Islands	9,350	193	1,200	$26
Norway	247,868	14,857	76,800	1,814
Spain	218,220	9,710	....	....
Sweden	22,450	710	....	....
Bermuda	582	12	....	....
Canada	547,346	23,904	4,897,753	104,546
Costa Rica	8,100	256	....	....
Guatemala	4,000	153	....	....
Nicaragua	15,201	685	4,875	122
Panama	11,215	380	9,000	180
Salvador	605	73	2,272	55
Mexico	939,572	32,842	141,278	3,934
Newfoundland and Labrador	100	20	....	....
Jamaica	546	32	3,000	120
Cuba	282,996	9,102	128,058	2,442
Dominican Republic	2,040	96	1,050	34
Argentina	315,059	16,907	....	....
Brazil	1,081,387	46,891	183,165	6,078
Chile	298,510	11,417	44,960	1,592
Colombia	138,650	4,037	13,500	321
Ecuador	6,750	180	492	18
Peru	209,500	9,705	30.000	750
Uruguay	112,000	3,360	....	....
Venezuela	34,225	1,549	2,100	47
China	748,760	28,016	21,792	489
Japanese China	88,450	6,191	....	....
Chosen	120,330	4,633	....	....
British India	135,282	4,618	....	....
Other British East Indies	22,400	731	300	15
Dutch East Indies	123,200	3,460	22,608	559
Hongkong	151,435	5,400	....	....
Japan	1,500,885	56,637	148,539	5,110
Australia	....	....	1,568,020	76,420
New Zealand	1,700	84	....	....
French Oceania	1,968	67	....	....
Philippine Islands	74,640	2,084	....	....
British South Africa	42,650	1,316	....	....
British East Africa	22,400	685	....	....
Total	7,871,639	$313,131	7,300,762	$204,672

IMPORTS OF TUNGSTEN-BEARING ORE INTO THE U. S. BY COUNTRIES—EXPORTS OF TUNGSTEN-BEARING ORE AND FERROTUNGSTEN METAL FROM THE U. S.

Imports

Countries	Tungsten-Bearing Ore, Tons	Tungsten-Bearing Ore, Value
Mexico	4	$2,614
Chile	1	1,661
Peru	26	26,500
China	53	35,178
Straits Settlements	50	44,688
Hongkong	151	144,658
Total	285	$255,299

Exports

Countries:	Tungsten and Ferrotungsten, Lb.	Tungsten and Ferrotungsten, Value
Brasil	49	$129

IMPORTS OF LEAD AND ZINC INTO THE U. S. BY COUNTRIES—DOMESTIC EXPORTS FROM THE U. S. (TOTALS ONLY)

Imports

Articles and Countries	Gross Weight, Tons	Contents, Lb.	Value
Lead Ore			
Canada	715	801,786	$28,916
Mexico	1,300	256,600	11,614
Chile	2,457	1,507,004	45,210
Total	4,472	2,565,390	$85,740
Lead Bullion and Base Bullion			
Mexico	6,831,268	6,683,731	$272,356
Lead Pigs, Bars and Old			
Panama	....	5,040	$162
Mexico	....	400	20
Total	....	5,440	$182
Zinc Ore and Calamine			
Canada	103	77,000	$1,375
Mexico	672	507,619	6,534
Total	775	584,619	$7,909
Zinc Blocks or Pigs and Old			
Canada	....	64,176	$2,246
Cuba	....	2,722	54
Total	....	66,898	$2,300
Zinc Dust			
Canada	....	18,262	$367

Domestic Exports

	Lb.	Value
Lead pigs (domestic ore)	372,510	$23,684
Lead pigs (foreign ore)	1,905,041	100,801
Zinc spelter (domestic ore)	11,076,264	910,311
Zinc spelter (foreign ore)	176,000	12,320
Zinc in sheets	1,336,244	164,420

IMPORTS INTO AND EXPORTS FROM THE U. S. OF PLATINUM IRIDIUM, ETC., BY COUNTRIES

Imports

Countries	Iridium, Osmium, Palladium, etc., and Native Combinations Thereof with Platinum, etc. Oz., Troy	Iridium, Osmium, Palladium, etc., and Native Combinations Thereof with Platinum, etc. Value	Platinum Unmanufactured Oz., Troy	Platinum Unmanufactured Value
France	2,045	$122,830	3,368	$322,486
England	123	23,622	16	1,568
Canada	134	14,988	13	1,227
Colombia	.....	....	3,878	321,039
Peru	.....	....	12	961
Uruguay	.....	....	4	420
Australia	77	8,337	.....	....
Total	2,379	$169,777	7,291	$647,701

Exports

	Platinum Unmanufactured Oz., Troy	Platinum Unmanufactured Value	Platinum Manufactures of Value
Spain	..	......	$200
Canada	38	$4,066	2,014
Mexico	..	......	2
British India	..	......	382
Dutch East Indies	..	......	410
Japan	..	......	115
Philippine Islands	..	......	65
Total	38	$4,066	$3,188

DOMESTIC EXPORTS OF MINING MACHINERY FROM THE U. S. TO ALL COUNTRIES

Countries	Oil Well Machinery Value	All Other Mining Machinery Value	Countries	Oil Well Machinery Value	All Other Mining Machinery Value
France	$1,313	$98,131	Peru	$1,810	$21,792
Italy	......	10,580	Venezuela	34,966	700
Norway	......	2,450	China	......	436
Spain	......	4,500	Chosen	......	532
Switzerland	191	....	British India	3,757	56,355
England	5,338	33,630	Dutch East Indies	40,520	6,303
Canada	57,306	57,310	Hongkong	......	151
Costa Rica	26,023	2,339	Japan	1,075	27,441
Honduras	......	2,168	Russia in Asia	......	750
Nicaragua	......	3,596	Australia	......	19,925
Panama	......	48	Philippine Islands	......	315
Salvador	......	344	Belgian Kongo	8,845	160,279
Mexico	33,344	126,932	British West Africa	......	8,759
Newfoundland and Labrador	......	2,941	British South Africa	......	154,710
Trinidad and Tobago	150	....	French Africa	7,255	14,170
Cuba	2,996	32,685	Portuguese Africa	......	33,224
Argentina	6,451	....	Total	$233,783	$910,832
Bolivia	197	....			
Brasil	......	1,725			
Chile	......	22,099			
Colombia	......	3,512			
British Guiana	2,246	....			

Consumption of Tungsten in 1918

An interesting summary of the consumption of tungsten in 1918 based on questionnaires distributed by the Bureau of Mines shows that the tungsten used in the making of tungsten powder, ferro and acid, from May to December, 1918, amounted to about 7,500,000 lb., from which it is estimated that the total tungsten used in such products for the calendar year 1918 amounted to about 10,000,000 lb. and that the amount of tungsten used in making malleable products during the same time was approximately 210,000 lb.

The quantity of high-speed steel made from May to December, 1918, was nearly 30,000,000 lb., from which it is estimated that the total weight of such steel in the year was somewhat in excess of 40,000,000 lb.; the tungsten content was probably nearly 7,000,000 lb. The tungsten steel made from May to December, 1918, was in excess of 45,000,000 lb., from which it is estimated that the total quantity produced in 1918 was approximately 62,000,000 lb.

The amount of 60 per cent concentrates required to make the tungsten powder, ferro and acid used in 1918 was approximately 13,000 tons, assuming that 1 ton of 60 per cent concentrates is reduced to 760 lb. of contained tungsten in ferro.

The accompanying diagram of manufacture of tungsten products gives a comprehensive survey of this field.

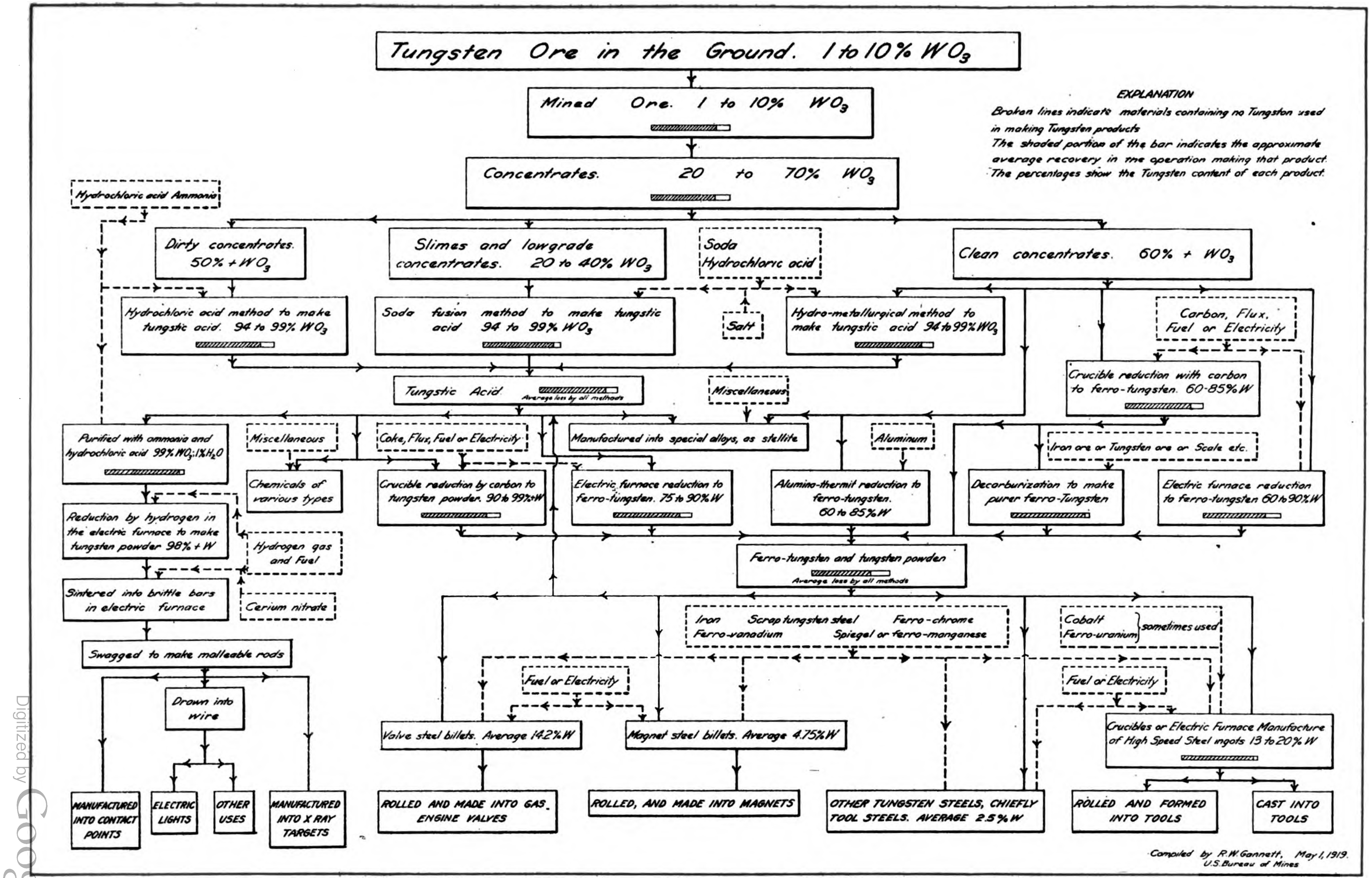

Tungsten Ore in the Ground. 1 to 10% WO_3
Mined Ore. 1 to 10% WO_3
Concentrates. 20 to 70% WO_3
EXPLANATION
Broken lines indicate materials containing no Tungsten used in making Tungsten products
The shaded portion of the bar indicates the approximate average recovery in the operation making that product.
The percentages show the Tungsten content of each product.
Hydrochloric acid Ammonia
Dirty concentrates. 50% + WO_3
Slimes and lowgrade concentrates. 20 to 40% WO_3
Soda Hydrochloric acid
Clean concentrates. 60% + WO_3
Hydrochloric acid method to make tungstic acid. 94 to 99% WO_3
Soda fusion method to make tungstic acid 94 to 99% WO_3
Salt
Hydro-metallurgical method to make tungstic acid 94 to 99% WO_3
Carbon, Flux, Fuel or Electricity
Crucible reduction with carbon to ferro-tungsten. 60-85% W
Tungstic Acid
Average loss by all methods
Miscellaneous
Purified with ammonia and hydrochloric acid 99% WO_3: 1% H_2O
Miscellaneous
Coke, Flux, Fuel or Electricity
Manufactured into special alloys, as stellite
Aluminum
Iron ore or Tungsten ore or Scale etc.
Chemicals of various types
Crucible reduction by carbon to tungsten powder. 90 to 99% W
Electric furnace reduction to ferro-tungsten. 75 to 90% W
Alumino-thermit reduction to ferro-tungsten. 60 to 85% W
Decarburization to make purer ferro-Tungsten
Electric furnace reduction to ferro-tungsten 60 to 90% W
Reduction by hydrogen in the electric furnace to make tungsten powder 98% + W
Hydrogen gas and Fuel
Ferro-tungsten and tungsten powder
Average loss by all methods
Sintered into brittle bars in electric furnace
Cerium nitrate
Iron Scrap tungsten steel Ferro-chrome
Ferro-vanadium Spiegel or ferro-manganese
Cobalt
Ferro-uranium
sometimes used
Swagged to make malleable rods
Drawn into wire
Fuel or Electricity
Fuel or Electricity
Valve steel billets. Average 14.2% W
Magnet steel billets. Average 4.75% W
Crucibles or Electric Furnace Manufacture of High Speed Steel ingots 13 to 20% W
MANUFACTURED INTO CONTACT POINTS
ELECTRIC LIGHTS
OTHER USES
MANUFACTURED INTO X RAY TARGETS
ROLLED AND MADE INTO GAS ENGINE VALVES
ROLLED, AND MADE INTO MAGNETS
OTHER TUNGSTEN STEELS, CHIEFLY TOOL STEELS. AVERAGE 2.5% W
ROLLED AND FORMED INTO TOOLS
CAST INTO TOOLS
Compiled by R.W.Gannett, May 1, 1919.
U.S. Bureau of Mines

CHART SHOWING USES OF TUNGSTEN

Growth of the Kelp Organism

By J. W. Turrentine

EARLY surveys of the areas of growing kelp, made by the Bureau of Soils from the Santa Cruz Islands, on the coast of Lower California, to the Peninsula of Western Alaska, showed in the aggregate such enormous quantities of kelp available that it appeared that here was the source of potash which might be developed into an important industry. The early surveys had little reference to the accessibility of the growing kelp or to the feasibility of harvesting it for fertilizer purposes, since at that time, of course, no plants had been constructed for the treatment of kelp, and it was not possible to bring to bear any information obtained in actual experience. Now for several years kelp potash plants have been in operation, and we are beginning to know how to estimate with some reliability the quantities of potash that can be obtained from kelp in actual commercial operations; and while these quantities are relatively small as compared with the total quantities existing as growing kelp, they are still large enough to warrant us in the belief that it will be possible to establish a kelp potash industry that for normal times will be both permanent and important.

To furnish the annual tonnage recently cut in California with certainty (400,000 to 500,000 tons), practically the entire areas of growing kelp of southern California and the islands contiguous thereto from Point Conception southward have been required. It is entirely possible that, after greater experience in the gleaning of kelp and the conservation of the kelp beds, these areas can be made to furnish considerably more than this. At present the kelp beds are yielding three or four crops of kelp per year.

Proper Harvesting Procedure

To obtain the maximum yields, the same procedure should be observed with regard to harvesting kelp that is observed with regard to harvesting any agricultural crop that is a perennial and renews itself promptly after harvesting. That is to say, sufficient time should be permitted to elapse for the growth to renew itself fully, otherwise only an imperfect yield is obtained. Now control of the kelp beds of California lies in the hands of the State Fish and Game Commission, who declare harvested areas closed to harvesters until the growth has renewed itself completely. This undoubtedly will result in a larger yield of kelp from each bed.

But with all this, a liberal margin must be allowed over the actual tonnage required to provide against unavoidable contingencies such as the destruction of a portion of the beds by storms or by disease, as happened during the summer of 1918 in some of the large beds in the Santa Barbara region. At the same time it is within the realm of possibility that areas of growing kelp can be enlarged by kelp farms, and that increased economy in harvesting, a larger number of crops per annum, and great improvements in the technology of the industry may all combine to bring about an enlargement of the industry here. And, besides, there are large areas of kelp on Puget Sound and in Alaska which to date are practically untouched, certainly some, and perhaps all, of which can be made to yield their quota of potash.

The kelp making up the beds of southern California is known botanically as Macrocystis pyrifera, and grows in about 75 ft. of water. Its place of growth is determined by a suitable bottom whereon it can secure anchorage, and tideways or surf to keep it supplied with fresh volumes of water from which it obtains its sustenance. It is held upright in the water by small air bulbs, pneumatocysts, one at the base of each leaf, which keep it pulled upward toward the light; and on reaching the surface it continues to grow, spreading out on the surface in large tangled mats. Its total length is probably from 100 to 150 ft.

How Kelp Is Gathered

With the cutting knives lowered into the water and cutting at depth of 6 ft., the harvester is forced through this mat of growing material and cuts it loose in quantities, dragging it on board by means of an apparatus similar to the familiar reaper of the grain harvester. It is then properly stored by means of a distributer operated mechanically, the entire apparatus making possible the harvesting of some 80 tons per hr., with a total crew of not more than five men, one in the engine room, one in the pilot house, one to man the cutter and its engine, and two to distribute the load. By this simple mechanism it is possible to handle tremendous quantities of material, and the problem of harvesting would be very simple indeed, if it were not for the long hauls occasioned at times by the distance of plants from the kelp beds, and the seasons of storms which interfere with harvesting.

The opinion has been expressed by operators of kelp harvesters that the kelp after having been harvested comes back in thicker growths, from which it has been concluded that there is a sort of stooling effect as in the case of alfalfa or wheat. The lack of definite knowledge as to what actually takes place at the bottom of the ocean, 75 ft. below the surface, makes it impossible to say whether this is a true statement of what actually takes place or not. But at least it is indicative of the completeness with which the kelp beds restore themselves after being cut over. It appears probable that when the growing tip on the end of a strand of kelp is cut off, that strand dies back to the bottom, and that the prompt regrowth is the result of what might be termed as undergrowth of shorter kelp shoots which spring to the surface promptly when the sunlight is admitted to them through the removal of the dense mass of kelp lying on the surface. When the so-called kelp roots, or, more properly, hold-fasts, are washed ashore, it is seen that there has been an actual branching; and it is quite possible that branching at the bottom is induced by cutting off the surface growth.

Investigations in Progress

Investigations are now in progress touching on all of these questions. They are purely biological and may be termed mariculture. Some day we may have developed a definite science, or a science as definite as that of agriculture, pertaining to the growing of such things in the sea. Of course, the cultivation of seaweeds is an old-established industry of Japan. There the developments within the past few years, or since the Russo-Japanese war, have resulted in the establishment of a kelp potash industry which has made possible the production of potash and iodine there in quantities adequate to supply domestic needs in these two commodities and to make possible their exportation in certain quantities.

This is astonishing, indeed, when we remember that the kelp there dealt with grows at the bottom of the ocean and is only a few feet in length. It is gathered at a depth of some 15 ft. almost altogether by woman divers, who go overboard with a knife, gather a bunch in their arms, cut it off, and come back to the surface with the bundle. If this can be done by the Japanese, it is evident that by the exercise of the proper science and economy we in this country, who have kelp growing in such a manner that it can be harvested in hundred ton lots by machinery, can likewise establish an industry of importance and value.

Fibrous Structure in High Carbon Steel

BY A. W. LORENZ

MUCH discussion has been aroused recently regarding the cause of the so-called "fibrous" or "woody" structure in high carbon and nickel steel forgings. This trouble seems to have manifested itself strongly in the manufacture of ordnance material. In this connection the writer wishes to present some interesting facts and data in connection with one ordnance contract in particular, which may throw some light on the general question of fibrous structure.

THE SPECIFICATIONS

The specifications required that a slab or test slice be cut from one end of the forging, which was approximately 9 ft. long and had a diameter of about 7 in. Out of this slice five transverse tests were required: Bend test A, tensile test 1, tensile test 2, tensile test 3, bend test B.

The actual test requirements need not be stated, as their consideration is unnecessary in this article. It is sufficient to state that the failure of any one of the above tests called for retreatment or rejection of the forging. Two forgings were made from one ingot, and it was the practice to cut the test slabs from the two forgings off the particular ends which represented the top and bottom of the original ingot. If a re-test was required it was then made from the end of the forging corresponding to the middle of the original ingot.

RESULTS

A tabulation of the results from about 700 tests gave:

	Top Per Cent Good	Middle Per Cent Good	Bottom Per Cent Good
Test No. 1	92	90	96
Test No. 2	43	31	82
Test No. 3	62	71	73

It will be noticed that No. 1 test (tensile) was invariably good. The probable reason for this will be discussed later. However, the outstanding feature of the above tabulation is the greater uniformity of the three tensile tests taken from the slice representing the bottom of the ingot, and the marked superiority of the results off the bottom slice as compared with the tests from the middle and top of the ingot. In fact, this superiority became so evident that the Government, to protect itself, later ruled that all tests should be taken from the top and middle positions. This at once suggests that the trouble, which generally manifested itself by fibrous fracture, is due to impurities of some nature which slowly arose to the upper portions of the ingots while cooling, leaving the bottom relatively clean. Several heats were therefore made, using the utmost care in the control of furnace conditions looking toward the production of steel free from impurities. These heats were no better (in fact one was worse) than the average.

ACCIDENT LEADS TO INTERESTING DEVELOPMENT

About this time an accidental oversight in the shop led to interesting developments. It was the practice to wash the ingot molds with tar in order to prevent surface cracks. On one heat this was overlooked, and the resulting forgings were 100 per cent good. This recalled to the writer the fact that the first two sample heats were also extremely good and that the only difference between these and subsequent heats was the use of clay wash instead of tar on the molds. In connection with this trend of thought it was noticed, while pouring several heats of metal into tar-washed molds without the addition of aluminum, that the metal boiled out until a cone over a foot high was formed at the top of the ingot, whereas with clay or graphite washed molds, the metal remained quiet.

Now it seems to the writer that the tar, in distilling, filled the otherwise good metal with gas which worked its way to the upper portion of the ingot, there to be entrapped by the freezing metal. This accounts for the superiority of the tests from the bottom end of the ingot. On forging, these blow-holes were forged out but not welded shut and consequently hairline cracks were developed which would have little effect on a longitudinal test but were quite detrimental to transverse tests. Of course slag and solid impurities would act in the same way, but microscopic and macroscopic examination of the fracture would disclose the presence of slag. Slag was certainly present, but not in undue amounts, and no more so in bad than in good samples. Moreover, oxidizing slag would be evidenced by a decarbonized zone under microscopic examination, and in the fracture itself perhaps by a discoloration.

This was not the case with the failures in question. A gray fibrous structure was evident in the fracture usually, and in well marked samples the break seemed worn with a smooth, silvery appearance usually associated with the inside of a blow-hole that has not been exposed to oxidation. Examination of unetched samples showed, under a magnification of 100, the presence of numerous pin-holes, so small as to be quite invisible at 100 magnifications after etching for grain structure. On treating the unetched samples with iodine, these small pin-holes gradually developed into cracks about ⅛ in. long in the direction of forging. Etching with hot sulphuric acid developed this structure still more strongly, showing cracks sometimes ¼ in. in length.

THEORY AS TO THE NATURE OF THE DEFECT AND WHAT MAY BE ITS CAUSE

As a general rule slag inclusions should possess a more appreciable thickness than was shown in the specimens mentioned above. The nature of the defect, therefore, seems to be a fine crack of no appreciable thickness, resulting as stated before from the squeezing shut of a blow-hole without actually welding it together. It will be noted in this respect that tensile tests No. 1 were invariably good, which may be explained by the fact that this test was in the region of greatest pressure during working under the press, and the blow-holes at this point may have been welded together to some extent. It may be stated that the forgings, being irregular in cross-section, were formed in a die, so that the pressure was always applied over test No. 1. On the other hand, the middle tests were responsible for the greatest number of failures and it is easy to believe that the center of the forging did not receive sufficient work to weld the holes at this point. On making a macroscopic examination of a slice adjacent to a test slice, after etching with hot sulphuric acid for about half an hour, it was found that whenever the center of the slab was sound, the central test would pass specifications, and when the center was badly pitted, the test would fail.

CHANGE IN MOLD WASH

Fourteen heats were cast using graphite as a mold wash instead of tar. The results were not nearly as satisfactory as expected, but were so much superior to the results on steel from tar-washed molds as to justify the statement that gassing was the cause of the trouble. The following percentages are based on all tests (to the number of several hundred) made after the change in method of testing which called for all tests to come from the top and middle:

Percentage of sets good (all three tensile tests fine:

Graphite wash, 68 per cent.
Tar wash, 34 per cent.

	Test 1, Per Cent	Test 2, Per Cent	Test 3, Per Cent
Graphite wash (good)	100	72	95
Tar wash (good)	91	37	66

In justice to the manufacturer, it should be noted that these figures do not refer to the ultimate percentages of accepted forgings.

EFFECT OF ADDITION OF ALUMINUM

It may be stated that little or no aluminum (not more than ½ oz. per ton of steel) was added to the steel (basic open hearth) after the use of graphite wash was resorted to. It is probable that the addition of a larger amount of aluminum or other scavenger would have resulted in still more improvement, but suspension of the contract shortly after the armistice was declared prevented further experimenting along this line. The above data would seem to indicate that fibrous structure is often due to the presence of gas cavities which during working have been squeezed out to a thin streak, without, however, being completely welded.

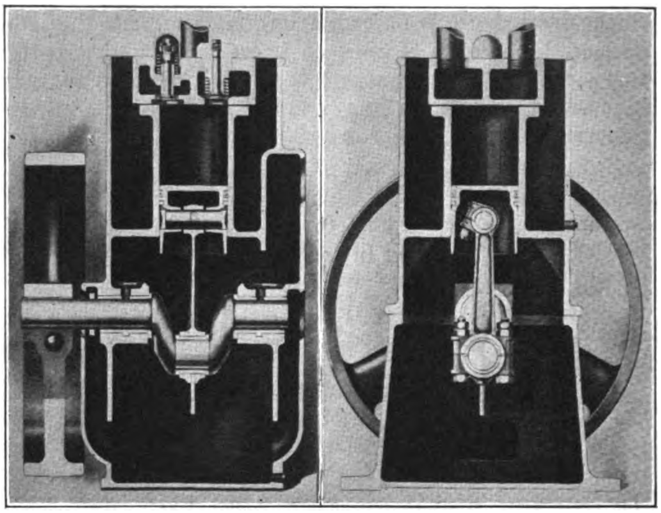
While the use of tar has been held responsible for the trouble alluded to in this particular instance, it is not the writer's intention to lay the blame for all fibrous or woody structure on the use of tar as a mold wash. It is well understood that some manufacturers may have found a way of using tar without encountering difficulty. It is also understood that any practice conducive to the formation of cavities and gas pockets will tend toward the formation of a fibrous structure during forging, provided the work is insufficient to completely weld the cavities together.

Importation of Tin

The War Trade Board Section of the Department of State will now issue licenses permitting the importation, on or after Sept. 1, 1919, of pig tin and all metal alloys containing tin, including tin drosses, tin oxides, solder drosses, type metals, anti-friction metals, waste metals and other metals containing tin, from points other than points of origin and without reference to the date of shipment.

Small Air Compressors

AT THE outbreak of the war, there was an urgent demand for a large number of small air compressors for military service where reliability was imperative. The small Imperial Fourteen type manufactured by Ingersoll-Rand had but recently been tested out. The field performance of these machines has been pronounced satisfactory and they are now being placed on the market. There are four sizes, and the capacity range runs from 3 to 45 cu.ft. per min. at pressures to 100 lb. per sq.in. The compressors can, however, be used for pressure requirements up to 200 lb. per sq.in., the horsepower needed being, of course, increased. They are single acting machines of the vertical type built for belt drive. Where driven from line shaft, tight and loose pulleys are supplied; where the use of an independent motor is planned, they are ordinarily furnished as a unit complete with motor, endless belt and short drive attachment. In the latter case a hardwood base plate is included with the standard equipment.



ONE TYPE OF A SMALL AIR COMPRESSOR

The machines are so well balanced as to operate satisfactorily if bolted to any solid flooring, but where permanency of installation is desired the building of a concrete foundation is advocated. The smallest size is built with ribbed cylinder for air cooling where the service is intermittent and with water cooled cylinder of the reservoir type for continuous operation. Larger machines are water cooled only, employing the reservoir jacket system except that, in the case of the largest size, a closed jacket for connection to pressure system is optional. In this connection it is worth noting that the reservoir cylinder design affords unusually ample water capacity and that both cylinder barrel and head are cooled. The manufacturer states that one filling of the water space will suffice for a 10 hour day's run.

In general design these compressors remind one strongly of an automobile engine. There is the same drop forged crank shaft and connecting rod, the die cast renewable bearings, the automatic splash lubrication system and general ruggedness and simplicity which have come to be recognized as guarantees of satisfactory service under all sorts of operating conditions.

It is pointed out, however, that these little units were designed to meet exacting efficiency tests and that, while simplicity was sought, efficiency was the outstanding requirement.

Vertical-Cylindrical Electric Furnaces for Heat-Treating and Shrinking

By A. M. Clark

DEMANDS made by the United States Government during the war period for the speeding up of ordnance manufacture caused remarkable improvements in electrical furnaces, which it is predicted will have a far-reaching influence on the commercial use of industrial heating in the future.

Both the Army and Navy Departments, faced with the necessity of manufacturing guns in great quantity and at short notice, turned to the electrical engineer to help them solve their problems.

The result was the development by the General Electric Co. of a new type of electrical resistance furnace used with success in heat-treating gun forgings and in shrinking the jackets on gun barrels of large caliber.

Two forms of furnace were developed—a high-temperature resistance furnace creating a temperature of 1800 deg. F., used in tempering, hardening, and gun forgings; and a low-temperature furnace up to 950 deg. F., used primarily for shrinking jackets over gun barrels and applicable to other practices, including shrinking collars on crank shafts and rims on wheels.

This type of shrinking furnace is constructed in sections and has been built up to a depth of 88 feet. The best example is installed in the Washington Navy Yard, where guns of large caliber were built during the war. The furnace is of the vertical-cylindrical type sunk into the ground to the required depth, a section of which is shown in Fig. 1.

Its internal construction is shown in Fig. 2. Furnaces consisting of more than one section are usually equipped with a hand control which permits bringing the charge up to temperature at a uniform rate throughout the length of the furnace, the maximum temperature used being approximately 950 deg. F.

When a one-section furnace is used, it is ordinarily provided with automatic control. Furnaces of more than one section are usually hand-controlled, but automatic control can be provided. A complete one-section furnace consists of a cylindrical section, cover, base and work base. The cylindrical section consists of top and bottom castings with supports, inner and outer casings enclosing the insulating material, and heating units and guards. The cast rings which form the ends of the section are recessed in such a manner that the sections can be stacked one above the other, which permits constructing a furnace of any desired height from standard sections. Provision is made for the unequal expansion of the inner and outer casings due to difference in temperatures. There is a minimum of through metal from the inner casing to the outer casing, hence the heat losses are reduced to a minimum.

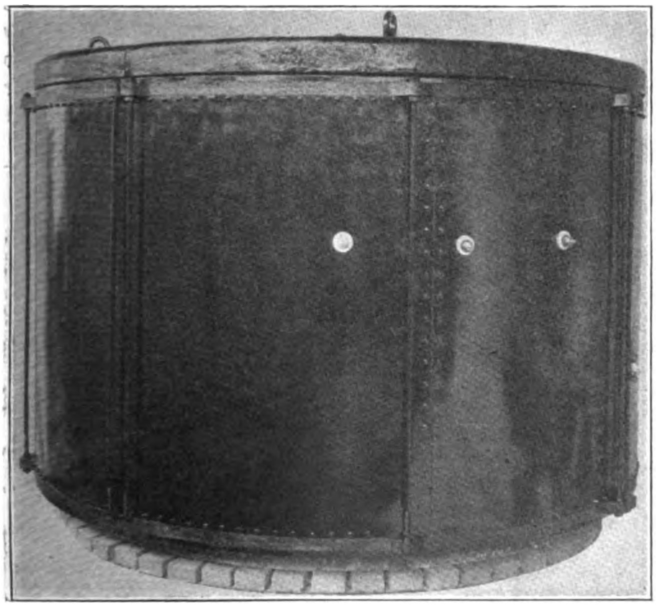


FIG. 1. SHRINKING FURNACE, ONE SECTION, WITH COVER

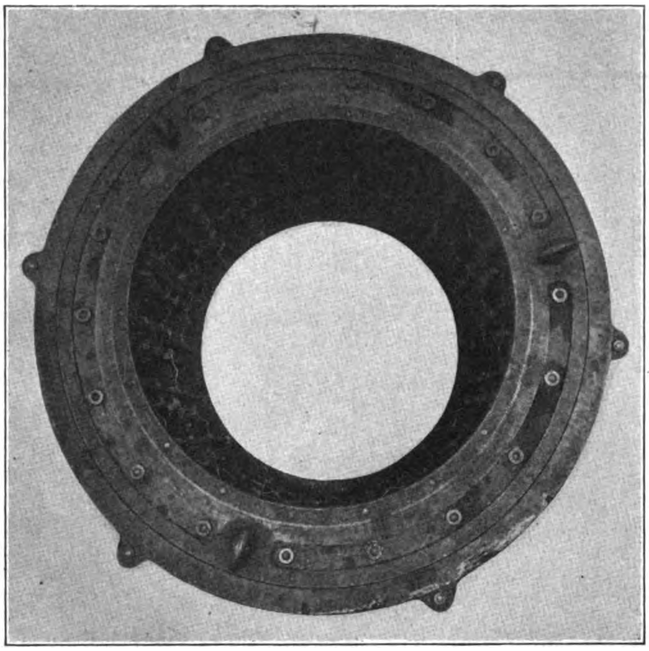


FIG. 2. INTERNAL CONSTRUCTION. DIAMETER INSIDE BORE, 4 FT.

The heating unit consists of a calorite ribbon mounted on a cast iron supporting plate, and insulated therefrom by suitable refractory material. A number of units are connected in series depending upon the voltage of the power supply. All connections are made with flat steel bus bars, as experience has demonstrated that the best connections can be made between flat surfaces, and steel will not oxidize at the temperatures employed in these furnaces.

The construction of the vertical-cylindrical high-temperature heat-treating furnaces involves the use of a heavy calorite ribbon supported on the inner walls of the furnace. The furnace is divided into a number of separate heating zones with an automatic temperature control for each. As indicated in Fig. 3, the walls consist of an inner lining of refractory brick and insulators backed up by a double course of heat-insulating brick and protected by a sheet metal casing. The ribbon supports and insulators are both of molded special compound laid in the lining of refractory brick with a spacing block of the same material placed between the insulators of adjacent windings, or zones. The insulators, spacers and spacing blocks are fitted at the back into a steel channel (*H*) which is in the form of a ring made up of a number of sectors tied together by bolted clamps, not shown in this figure. The spacing block (*A*) acts as a protecting buffer for the ribbon support insulators and any blow is transmitted to and distributed by the channel (*H*). An opening is provided in the spacing block (A) for the charge pyrometer tube, with a similar

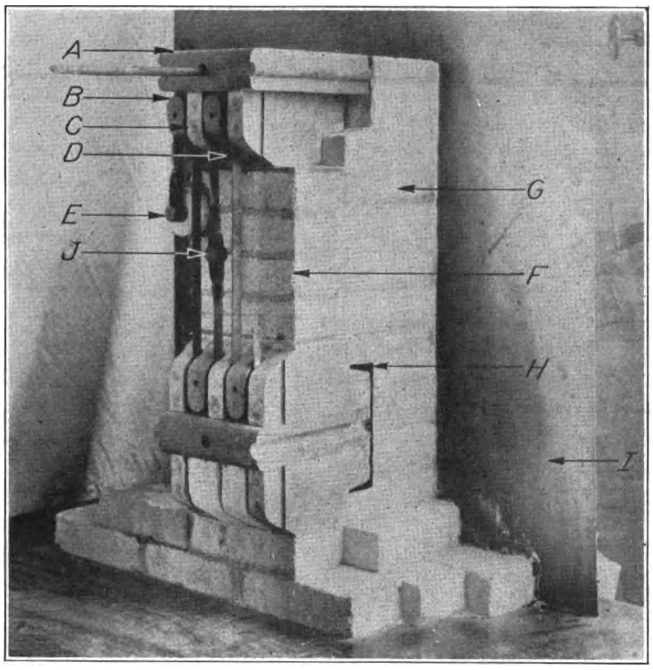


FIG. 3. SECTIONAL VIEW, SHOWING CONSTRUCTION OF WALLS AND REFRACTORIES CONVEYING HEATING RIBBONS

opening for the ribbon pyrometer in the support insulator at (*D*). The ribbon is welded to the terminal stud (*E*) and adjacent lengths of ribbon are joined by welding to the splice piece (*J*). It will be noted that the ribbon insulators are protected from mechanical injury by the spacing blocks and the shape of the former is such that any scale or dirt cannot accumulate and cause short-circuiting of the ribbon winding but will fall to the bottom of the furnace. The ribbon insulators being imbedded and forming a part of the furnace wall hold the ribbon firmly in place and eliminate the need of any form of metallic support with the inherent weakness of the latter at high temperatures. Furthermore, the omission of all metal, except through ribbon windings, insures quick heating of the furnace and reduces to a minimum the waste of energy due to heat storage.

HEAT-TREATING GUN FORGINGS IN THE ELECTRICAL FURNACE

Each section is provided with a control panel, and is controlled independently of the other sections. This is accomplished by very accurate and sensitive automatic controlling instruments, one for each section, operating in conjunction with suitable relays and a contractor, so that when the temperature reaches the value for which the instrument is set, the relays and contractor are operated to disconnect the section from the power line. When the temperature has fallen only a few degrees the relays and contractors are operated in the reverse order, again connecting the section to the line. Fig. 4 shows the control instrument, and Fig. 5 shows a control board for a group of furnaces, with the instruments on the sub-base.

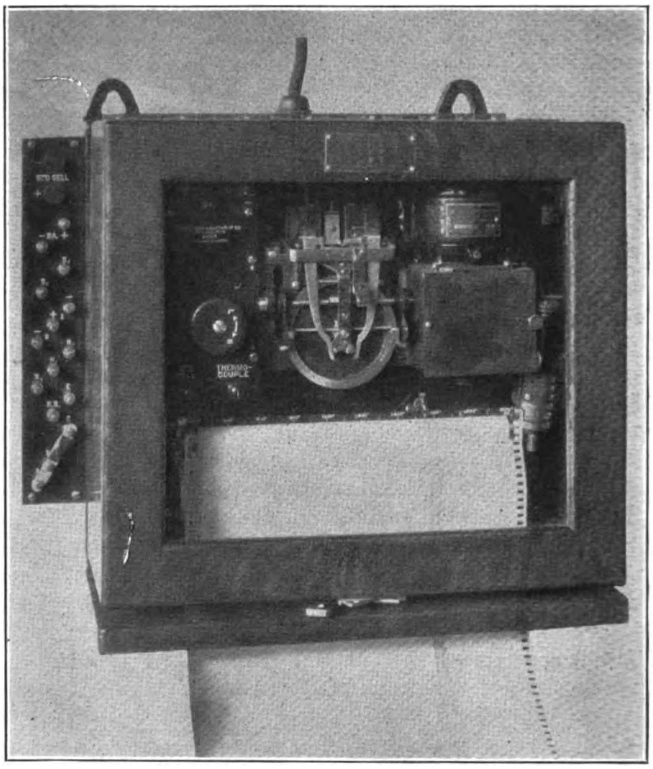


FIG. 4. TEMPERATURE RECORDER CONTROLLER FOR CONTROLLING TEMPERATURE AT TWO POINTS

The instrument may be set to hold any desired temperature, and is provided with a paper roll and recording mechanism, so that indicating, recording and controlling features are all combined in a single instrument, and charts are available for record and reference.

The temperatures are measured by means of thermocouples, which experience and research have developed into exceedingly accurate and reliable devices. Two of these thermocouples are used in each furnace section, one near the resister, and the other against the charge.

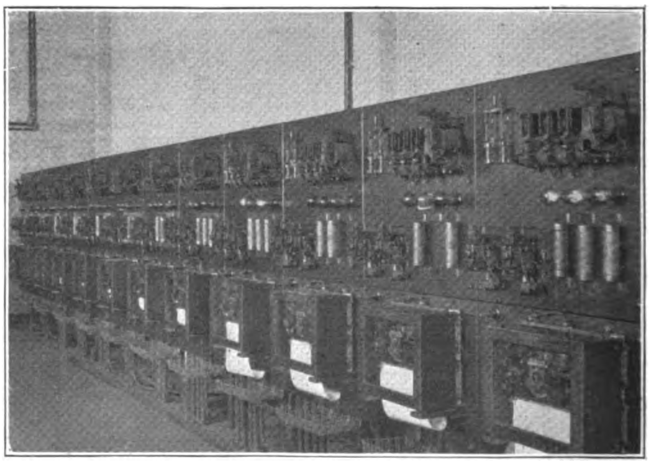


FIG. 5. AUTOMATIC PANELS AND CONTROL INSTRUMENTS

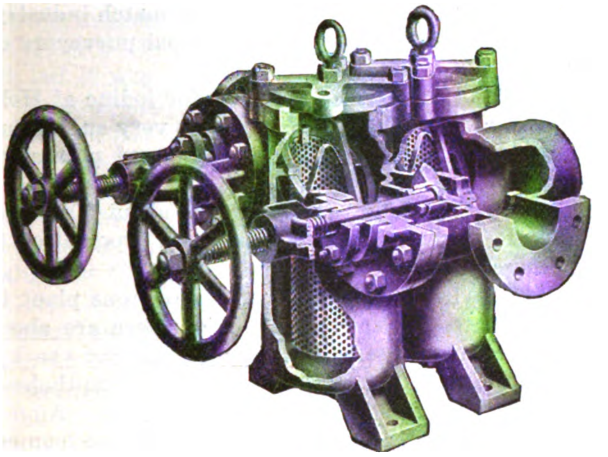
Probably the largest installation of this apparatus is in the plant of the Tioga Steel & Iron Co. of Philadelphia, Pa., a concern taken over by the Government for the war and engaged almost wholly in naval ordnance activity.

With cessation of hostilities and the practical abandoment of munition work, engineers are turning their attention to the use to which these furnaces can be put in industrial work. There are a large number of heat-treating processes in the manufacturing industries requiring temperatures from 900 to 1800 deg. F. Chief among these may be mentioned drawing and annealing carbon steels, drawing high-speed steels, annealing brass and copper, and baking vitreous enamels. The disadvantages of electrically-heated furnaces constructed and equipped with heating units and temperature-control systems as described are automatic control of the temperature, minimum temperature variation in the furnace, maximum rate of heating the charge, uniform heating throughout the charge, maximum efficiency in heat treating, elimination of scale due to oxidation, duplicate results day after day, and elimination of combustion methods with their attendant uncertainty of results and general fuel problems.

Industrial Heating Department,
General Electric Co.,
Schenectady, N. Y.

Pipe Line Strainer

The G.R. duplex strainer has been especially designed for installation in the suction or discharge lines of lubricating or fuel oil systems for the removal of solid foreign material in suspension. Such foreign material, if not removed, makes the lubrication inefficient and may seriously damage bearing surfaces. Similarly, sediment in fuel oil tends to clog the burners, reducing their capacity and necessitating frequent cleaning.



PIPE LINE STRAINER

This strainer is also suitable for straining the water supply from such sources as rivers and lakes to prevent weeds, sticks, marine plants and small fish from entering the pipe lines.

The strainer consists of a cast-iron body containing two perforated steel or brass baskets. The valve arrangement permits of the complete removal and cleaning of either basket while the other remains in service.

In operation the oil or other liquid enters the inlet connection of the strainer and passes into whichever basket is in service. The solid matter remains in the basket, the clean liquid passing through the perforations and thence out of the strainer.

All cast-iron sections are cylindrical, resulting in maximum strength. The valve mechanism is very simple and the valves are easily re-ground. This apparatus is described in Bulletin 1150 published by the manufacurer, the Griscom-Russell Co., 90 West St., New York City.

Sixty-Inch Gyratory Crusher

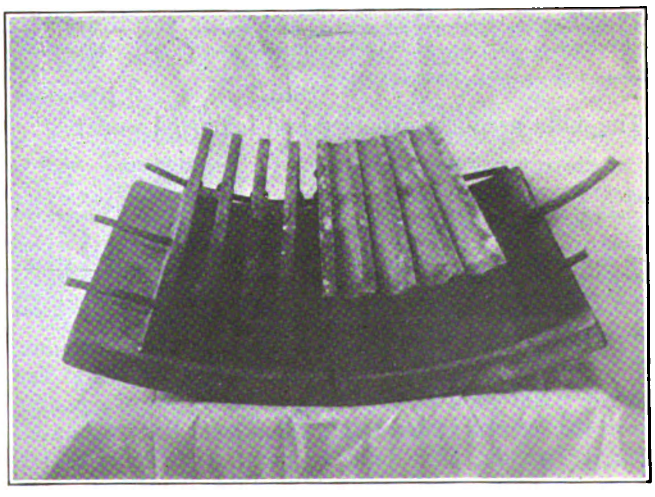
Steam shovel dippers and gyratory crushers have been trying to outgrow each other for forty years. Half-yard, yard, two-yard and five-yard dippers have had their counterparts in 7, 15, 36, 42 and finally 60-in. intake gyratory crushers. The latest achievement is the giant "Bulldog" having two intakes, 190-in. annular segments 60 in. wide, and an output of 2500 tons per hour. The Traylor Engineering & Mfg. Co., of Allentown, Pa., built this 60,000 tons per day world's record machine on special order in 3½ months. The dimensions and weight of the principal parts are:

Height	17 ft. 8 in.
Diameter	19 ft. 6 in.
Shaft length	21 ft.
Shaft diameter	3 ft.
Receiving openings	15 ft. 10 in.
Pulley	7 ft.
Eccentricity	2 in.
Shaft	28 tons
Shaft bearings, etc	34 tons
Head	30 tons
Top shell (2 pieces)	54 tons
Middle shell	50 tons
Bottom shell	47½ tons
Bottom shell lining	5 tons
Spider	30 tons
Complete crusher	278½ tons

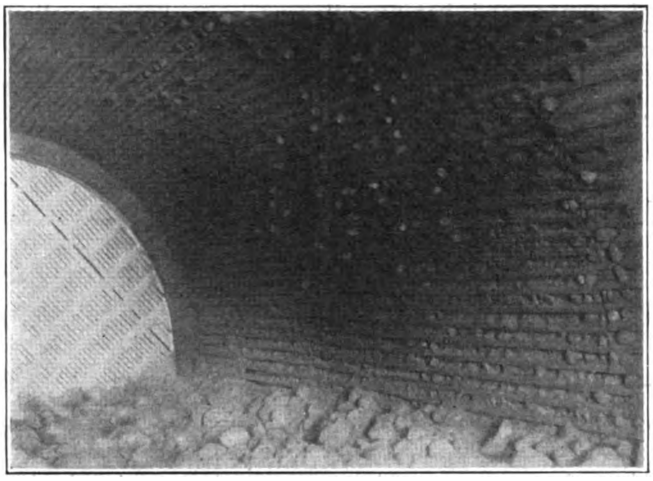
The capacity with limestone reduced to 8 to 9 in. is from 2500 to 3000 tons per hr. The power required is 75 hp. with light running to 350 hp. with full load. The rate of running is 240 r.p.m. About 9 bbl. of lubricating oil is used in the system and is pumped continuously through the eccentric bearings, etc. Patents are applied for, Messrs. Richard Bernhard and L. J. Hewes being the engineers in charge of the development.

New Tube Mill Lining

Metallurgists will be interested in the description and illustration of a new tube-mill lining developed by F. B. Kilbourn of Montreal and manufactured by Burnett & Crampton, Rigaud, Quebec, Canada. As shown in the illustrations it consists of a series of chilled iron T-bars set on edge and spaced from three-



DETAIL OF TUBE MILL LINING



SHOWING CORRUGATED SURFACE DEVELOPED DURING USE

quarter inch to one inch apart. The volume between the bars is filled with a rich cement grout, and when this is set the tube mill is ready for operation. After a few hours' running the concrete is somewhat worn, leaving the bars protruding and giving a corrugated surface which effectually lifts the contents of the mill. It is reported that the mill, as shown in the illustration, suffered a wear of only one-eighth inch after 5000 hours of operation. It is reported also that the wear is uniform.

Synopsis of Recent Chemical and Metallurgical Literature

Progress in Japanese Chemical Industries — Mr. Michel Annebault has given in the December, 1918, issue of *Chimie et Industrie* quite a lengthy description of the economic evolution of modern Japan, of which the following is a succinct abstract.

In 1858 the total Japanese foreign commerce, export and import, amounted to about $13,560,000; in 1894 it was about $119,195,000; in 1904 about $156,635,000, and in 1916 it reached about $435,153,000.

During 1916 the figures for export and import tradings with the principal countries were:

Exports to:	About	Imports from	About
France	$33,066,000	France	$2,154,000
China	99,556,000	Germany	2,139,000
British India	36,998,000	China	56,123,000
United States	175,770,000	British India	92,712,000
Great Britain	53,030,000	United States	105,428,000
Total	$398,420,000	Great Britain	42,237,000
		Total	$300,793,000

The main products exported and imported were:

	Exports About	Import About
Sugar	$9,005,000	$9,368,000
Pharmaceuticals	20,516,000	28,635,000
Dyes		4,382,000
Oil and fats	10,186,000	8,982,000
Paper (raw materials)	7,418,000	8,395,000
Ores and metals	74,550,000	8,376,000
Manufactured metals	8,572,000	5,510,000
Machinery	18,052,000	16,166,000

The cheap labor conditions in Japan greatly favor her industrial development. Thus, for example, official figures for 1906 gave as labor wages per day: Carpenter about 45c, printer about 26c, tailor about 23c; in match factories women were paid 3c per day to label match boxes. A noteworthy remark is that in 1904 out of 558,041 persons employed in industrial factories 313,001 were women. The very efficient propaganda that "Japan must break foreign competition, otherwise she will be lost," is contributing more than anything else to keep the standard of wages so very low.

In 1914 the chemical industry in Japan was practically embryonic, but now the Japanese not only manufacture most of the chemicals needed for the rapidly increasing local consumption, but they also export a great number of them. To mention only a few:

Potassium Chlorate—Previous to the war potassium chlorate was imported mainly from Germany; but since importation was forcibly stopped plants have been installed for the treatment of seaweed, and now the Japanese can produce 10,000 tons of potash annually, and have even become exporters of potassium chlorate to the United States. Progress is now being made toward the large-scale manufacture of potassium cyanide.

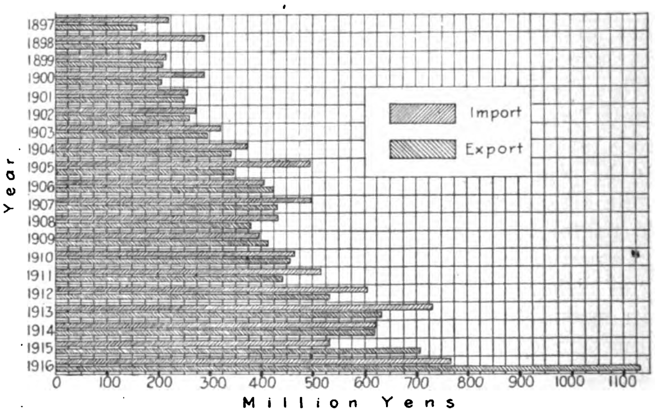
Phosphorus—Practically all the phosphorus needed in pre-war times was imported from Europe; now the local production is amply sufficient for the increased needs.

Matches—The rapid development of the industries of phosphorus and potassium chlorate is intimately connected with the progress of the Japanese match industry. Japan is now one of the world's principal purveyors of matches.

Iodine—The treatment of seaweed for iodine at Hokkaido, Kanagawa, Chiba and Fukuoka is very successful. Japan is now a big exporter of iodine and potassium iodide.

Sulphuric Acid—Japan produces now about 3000 tons of 52 deg. B. sulphuric acid per day, and exportation is rapidly increasing.

Gas Plants—In 1870 there was only one gas plant in all Japan, located at Yokohama. Now there are about 120 plants manufacturing mainly coal gas and the by-products, ammonium sulphate, benzol, cresol, napthalene, phenol, anthracene and other tar derivatives. Ammonium sulphate is also manufactured in electrochemical plants for the fixation of atmospheric nitrogen. Phenol is manufactured synthetically, mainly at the Osaka Dye Works.



TOTAL JAPANESE FOREIGN COMMERCE—IMPORT AND EXPORT

Artificial Fertilizers—In 1887 the first artificial fertilizer plant was installed at Kamayabori, but this industry progressed slowly, due to the fact that the Japanese relied mostly on natural fertilizers. With the increased agricultural demand the production of artificial fertilizers has progressed proportionately, and now it is one of the well-established industries.

Artificial Dyes—The industry of artificial dyes, which was practically nil before the war, is now represented by 89 factories, and the life of this industry is more or less insured by government protective laws.

Pharmaceuticals—In 1884 there was in Japan one plant for the manufacture of pharmaceuticals, and this one needed government help for its upkeep. Now there is a number of successful plants, and they are already practically independent of foreign import.

Oils and Fats—The production of oils and fats reaches now about $13,950,000, and this has contributed to the development of the industrials of soap (about $4,443,000), candles, (about $2,377,000), fatty acids and glycerine (about $2,584,000), etc.

Paints, Gum Lacs and Varnishes—These industries started in 1887 with a small plant (the Nippon Paints Co.), and it had a hard struggle up to the time of the war. Now there are many plants with a production worth about $1,550,000, and the demand is on the increase.

Rubber—The first plant in Japan was founded in 1887 at Asakusa. At the present time there are nearly 100 plants, and they are able to export rubber and rubber products. Japan's exportations of rubber tires alone amount to about $2,100,000.

Ceramics—The crockery and porcelain industry is very old, but it was not until 1868 that Occidental processes of manufacture were introduced. Since then the total production has increased to more than $9,000,000.

Enameled Ware—Previous to the war all the enameled metal-ware had to be imported from Europe; now the local industry supplies all the nation's needs and exportations amounting to about $1,035,000 are made to Australia and China.

Glass—Starting with a small plant in 1871, the glass industry has grown until glass of different qualities is exported to the amount of about $5,170,000.

Cement—In 1880 the first cement plant was installed in the Department of Yamagushi. This plant's production has increased tenfold (about 4,000,000 tons), and there are now 20 other plants, mostly in the Departments of Tokio and Orsake.

Paper—Occidental methods for the manufacture of paper were introduced in 1868. At the present time there are a great number of paper factories, which, besides producing the 225,600 tons of common printing paper for local use, also export to China and India about $8,800,000 worth. The manufacture of the special Japanese paper has also increased since the introduction of machinery, and production has reached about $10,600,000 worth and is still increasing.

Plastic Materials—This is a very recent industry in Japan, although practically all the camphor, which is one of the main raw materials, comes from Japan.[1] The first celluloid plant was installed after the Russo-Japanese war. There are now 12 plants, producing annually 2700 tons of celluloid, and celluloid is exported to Europe and America.

Sugar—Although the first beet sugar factory was put in operation in 1881 only a negligible quantity was produced up to the time when Japan came into possession of the Island of Formosa, which is a great producer of sugar beets. The industry has progressed to such an extent that in 1916 Japan practically supplied her own needs and now she can even export sugar.

Electrochemistry—Japan has taken up and greatly developed this industry, and besides the electrochemically manufactured products already mentioned, she produces now on a large scale carbides, artificial graphite, metallic sodium, caustic soda, sodium chlorate, nitric acid, chlorine and many other chemicals.

In viewing the progress made by Japan in the main chemical industries it becomes evident that she has directed her mental and monetary resources to the manufacture of the products she imported in pre-war times mainly from Germany, and that she has succeeded in emancipating herself to such an extent that she will become Germany's successful competitor in the foreign markets.

Recent Chemical and Metallurgical Patents

Complete specifications of any of the United States patents abstracted herein may be obtained by remitting 5c. each to the Commissioner of Patents, Washington, D. C.

Calcium Bisulphite.—In order to produce calcium bisulphite continuously, ALBERT G. HINZKE of Toronto has designed an apparatus in which the counter-current flow of lime water and sulphur dioxide may be reversed at will, thus preventing the formation of incrustations which tend to clog the openings in the absorbing system. Fig. 1 shows the apparatus in vertical cross-section. The four compartments are lined with acid-resisting material and are provided with a number of perforated splashboards. Assuming that the sulphur dioxide enters at the left, its course is indicated by the arrows. In this case the lime water is introduced through the central pipe in the top of the right hand chamber and is circulated progressively through the other compartments. The circulating system is shown more clearly in Fig. 2. A flow-box is interposed between each two compartments and the corresponding pumps. This box is divided by partitions in such a manner that, while a constant circulation is maintained through the sprayers in each chamber, there is also a movement of liquid from chamber to chamber toward the end at which the gas enters. Here the saturated solution is drawn off continuously to a storage tank. (1,303,314; assigned, by mesne assignments, to Ainwell G. McIntyre; May 13, 1919.)

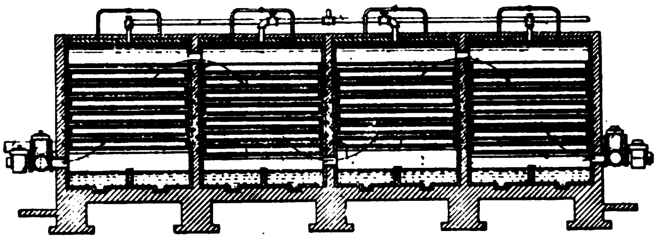


FIG. 1. CROSS-SECTION OF ABSORBER

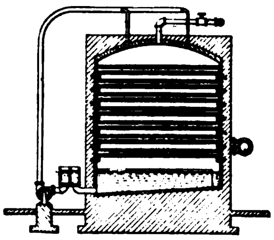


FIG. 2. CIRCULATING SYSTEM

---

[1] EDITOR'S NOTE.—The output of camphor in 1917 was about 10,000,000 kin (a kin is 1.325 lb.), of which 70 per cent was produced in Formosa and 30 per cent was supplied by domestic producers. But since the wartime the output has gradually decreased on account of rise of wage. Last year's output was only 8,000,000 kin. This year's production is estimated to be still less, viz., 6,000,000 kin. Nowadays about 12,000,000 kin is annually demanded by celluloid makers, while camphor culture is too slow to meet this demand. This shortage of material will be supplied only by the foreign producer.

Electrodes for Caustic Cells.—CLARENCE W. MARSH of New York City has patented an improved construction of electrodes for cells engaged in the manufacture of chlorine or caustic alkali, one application of which is shown in Fig. 3. As the old anodes wear out they are replaced by those of sectional type (5); at the same time the flat perforated cathodes are replaced by bent plates (8) so shaped that the distance between electrodes is approximately constant. The great advantage of this style is that gases which form on the anodes in rising to the surface strike the under side of the section immediately above and are deflected into the inactive center part of the cell. In this way is provided an increased resistance of the upper part of the cell due to excess gas in the electrolyte, and better circulation is maintained. Step-construction of cathode increases the support for diaphragm (12), which may be correspondingly reduced in thickness with an attendant lowering of electrical resistance. Altogether, this construction reduces the necessary impressed voltage by 0.5 volt. (1,302,824; May 6, 1919.)

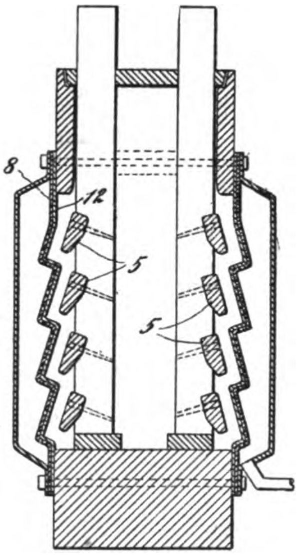


FIG. 3. ELECTRODE

Electric Furnace. — O. A. COLBY and FRANK THORNTON, JR., of Pittsburgh, Pa., have patented an electric furnace with protected electrodes (20) and a compound resistor capable of continuous operation at high temperatures. When the furnace, such as shown in Fig. 4, is held at about 1000 deg. C., the hottest portion of the carbon resistor is nearly 2000 deg. C., due to the negative temperature resistance of carbon. Now in order to prevent the hearth foundation (12) from being overheated despite the special refractory (18) the resistor is sectionalized to have a lower layer of high resistance material, thus carrying a lesser amount of current. Various combinations are suggested, such as a layer of crushed graphite (16) above, renewable through side hoppers, and underlain by crushed charcoal (17). Or the crushed graphite may form the lower layer and the furnace hearth itself consist of carborundum brick. The same construction reversed will form a chamber heated from both top and bottom. Or, wedge-shaped rods of carborundum, graphite or amorphous carbon may be buried in the upper part of a crushed graphite layer. A further expedient to prevent overheating of the hearth refractories consists of providing a pre-heating chamber in the foundation brickwork (12). (1,306,250-251-289; assigned to Westinghouse E. & M. Co.; June 10, 1919.)

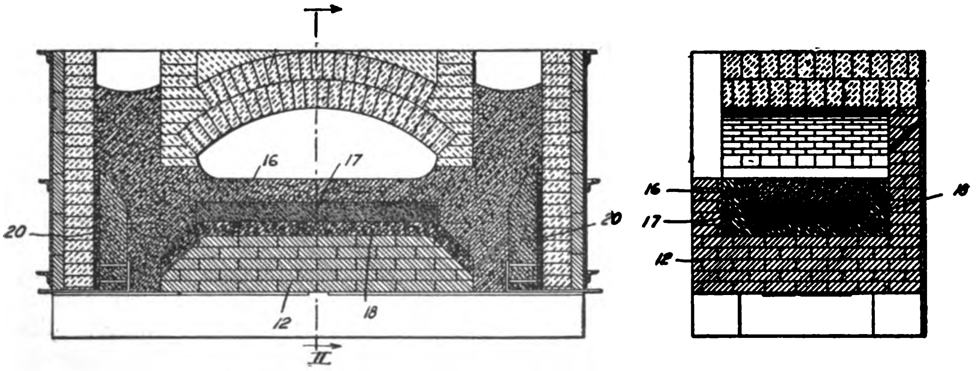


FIG. 4. ELECTRIC RESISTANCE FURNACE

Disintegrating Metals.—E. J. HALL of New York City patents a method for disintegrating metals, in which molten metal drops in a fine stream through an atmosphere of inert gas into a circulating bath of cold liquid which does not react with the metal in any way. In this way chilled particles of pure metal are available for further grinding under inert oil to produce particles of the required size. (1,306,060; assigned to Metals Disintegrating Co.; June 10, 1919.)

Electric Furnace.—IVAR RENNERFELT of Djursholm, Sweden, has patented a furnace, shown in Fig. 5, wherein electrodes (1) project through a movable roof (2) and make contact with renewable granular carbonaceous material held on shelves at the side walls. The brickwork of the furnace is here protected from excessive heat by a thick lining of magnesite or carbon bricks (7). Various shapes of furnaces can be adapted to polyphase current, connected either in star or delta, to hold one or more shallow crucibles (4) for melting glass or metals, or the furnace may be made into a hearth. Residue from the combustion of electrodes is by this construction kept from contaminating the bath, and a strong and uniform heat had by the electrode arrangement and by reverberation from the furnace walls (1,305,167; May 27, 1919.)

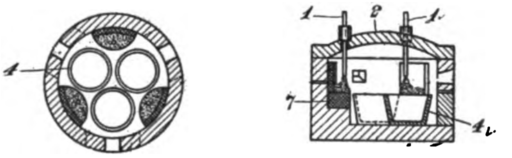
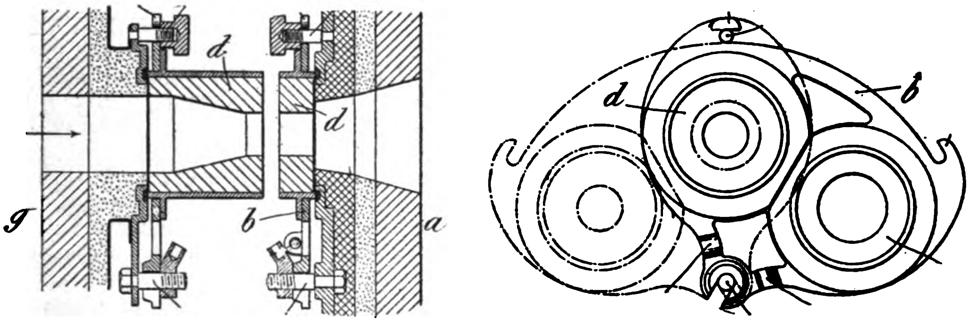


FIG. 5. ELECTRIC FURNACE WITH MOVABLE ROOF

Alloy for Glass Molds.—An alloy consisting of copper, 56-64 per cent; nickel, 13-17 per cent; zinc, 10-15 per cent; iron, 10-15 per cent, resists oxidization at high temperatures. In addition, it can be machined easily, so that it is especially suitable for the manufacture of glass molds. (1,310,363; FOSTER MILLIKEN of Lawrence, N. Y.; July 15, 1919.)

Deborating Chile Saltpeter.—ROBERT P. CALVERT and OTHO L. THOMAS of Wilmington, Del., have devised a novel method for removing borates from crude saltpeter or the refining by-product known as the potash crystal fraction, which contains from 20 to 50 per cent potassium nitrate and from 3 to 7 per cent boric acid, etc. Sufficient mineral acid is added to liberate all the boric acid, the salts are evaporated to dryness, methyl alcohol added and methyl borate distilled off in the presence of a dehydrating agent. The ester is hydrolyzed, freeing the boric acid and converting the alcohol back for another cycle. Since borax is a very injurious impurity in all the uses to which caliche salts are applied, such as fertilizer, black powder, etc., this process should prove to be important. (1,308,576-7; assigned to E. I. du Pont de Nemours & Co,; July 1, 1919.)

Ports for Tilting Furnace.—A. M. AUBERT of Billancourt, Seine, France, patents a new port for a tilting regenerative furnace, fired by liquid fuel, shown in Figs. 6 and 7. Each regenerator and the adjacent furnace and has a lunette (*b*) attached to it, but separated from each other by a space sufficient to allow entrance of a pipe carrying the liquid fuel. In the position shown, hot air from the regenerator (*g*) passes through the fire clay ports (*d*) into the furnace chamber (*a*), there burning the sprayed fuel. At the other end, the hot gases pass off through larger ports into another regenerator. Upon reversal, the fuel valves are changed, and all lunettes shifted as shown in dotted lines (Fig. 7), so that the small inlet ports may be replaced by larger exit ones and vice versa. (1,304,725; May 27, 1919.)



FIGS. 6 AND 7. A NEW PORT FOR A TILTING REGENERATIVE FURNACE

Burning Crushed Coal.—J. M. SCHULTZ of Chicago patents a method of burning crushed coal, and various forms of burners applicable. He proposes to take fuel and crush it as fine as practicable without previous drying, thus being much coarser than pulverized coal burned in suspension. This fuel is then blown into a burner at a uniform rate with sufficient air to burn the fixed carbon to CO through tangential tuyeres near the top of the annular pot shown in sectional perspective in Fig. 8. Here the contained water is first evaporated, then volatiles driven off, and the remaining coked particle pursues a downward helical path. By the time the coarsest piece is consumed, the remaining ash is fused, and this slag drips out of the lower hole 6 in liquid condition. The products of combustion largely are deflected inward and upward, blowing out the upper hole 4, there to be burned completely by auxiliary air drawn through the outer passages 9. The pot itself is protected from inward scour by a self-renewing layer of viscous fuel ash, while destruction by superheating is prevented by the air currents through 9. Clogging of the slag hole 6 is prevented by a portion of the flame pulsating downward at this point. (1,306,233-234-235; assigned to Schutz Hawley Co.; June 10, 1919.)

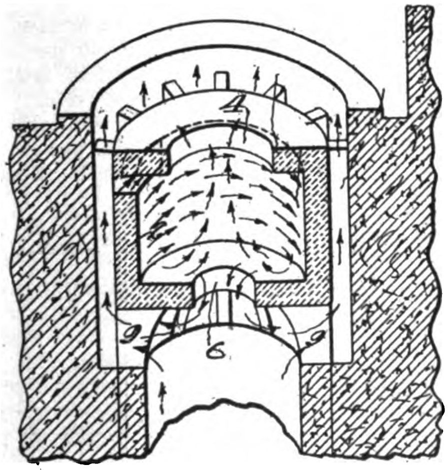


FIG. 8. METHOD OF BURNING CRUSHED COAL

Molybdenum-Tungsten Alloy.—FREDERICK G. KEYES has patented a process for the manufacture of a molybdenum-tungsten alloy which may be drawn into wire and used for lamp filaments or resistance-wire for electric tube-furnaces. Chemically pure MoO_3 and WO_3 are pulverized, mixed in desired proportions and reduced to metallic form by heating to between 800 and 1000 deg. C. in a current of hydrogen or carbon monoxide. The metals are mixed with water, molded into a bar under pressure, dried, and then heated to 1200 deg. in a stream of hydrogen to reduce any molybdenum oxide that may have been formed during the drying and molding operations. The bar is again heated by an electric current until the temperature has attained that of the melting point of molybdenum. The alloy thus formed preferably contains about 20 per cent molybdenum, and when heated to between 800 and 900 deg. C. is both malleable and ductile. (1,308,907; assigned to Cooper-Hewitt Electric Co., July 8, 1919.)

Elimination of Carbon Dioxide and Oxygen From Electric Furnaces.—JOHN THOMSON of New York has patented a process by which the practical use of an electric resistor furnace, for the distillation of zinc, is made possible by covering the charge with a layer of granular carbon. The carbon resistor is located above the charge and heats by radiation through this granular layer, which is maintained at a temperature between 1000 and 1100 deg. C. At this temperature the following reaction takes place, from left to right:

$$CO_2 + C \rightleftharpoons 2CO$$

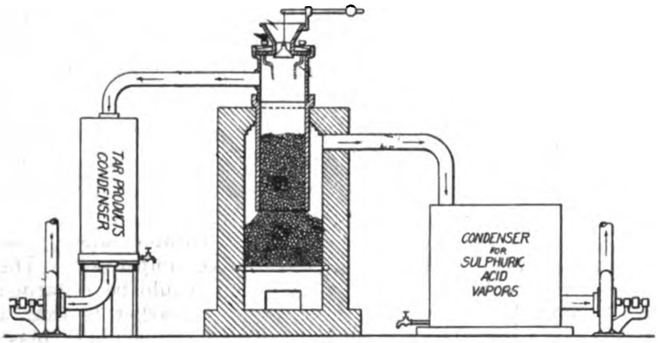
Any oxygen present in the furnace will react with zinc to form "blue powder," and thus zinc oxide will be converted to metallic zinc and carbon monoxide according to the equation:

$$ZnO + C = Zn + CO$$

The granular carbon layer acts as a filter through which the zinc vapors and gases must pass, the oxygen and carbon dioxide being eliminated. (1,308,879, July 8, 1919.)

Sulphidizing Solution.—In view of the fact that the majority of plants using the sulphidizing process for the flotation of oxidized ores are so situated that the soluble sulphides required for the treatment have to be secured from distant points, RAYMOND F. BACON proposes to manufacture the desired sulphide solution at the flotation plant. Natural alkali and alkaline earth materials, such as lime and the carbonates, hydroxides and borates of the alkali or alkaline earth metals, are available in mining regions and afford a cheap source of alkali, while iron pyrites, copper pyrites, flotation concentrates, etc., may be used to supply the sulphur. A mixture of sulphur-bearing and alkali-bearing material in appropriate proportions is heated to 600-700 deg. C. in a retort or muffle, after a preliminary heating at a lower temperature to remove moisture and water of crystallization. The soluble sulphide formed during the heating may be extracted by leaching with water, or the contents of the retort may be introduced directly into the water of the sulphidizing tank and the sulphide solution formed *in situ*. (1,310,151: assigned to Metals Research Co. of New York; July 15, 1919.)

Continuous Distillation of Sludge Acid.—A furnace for the fractional distillation of sludge acid has been devised by INGENUIN HECHENBLEIKNER and PETER S. GILCHRIST of Charlotte, N. C. The furnace consists of an outer casing of acid-resisting masonry, provided with a grate and an ashpit. Through the top of this casing a cylinder of acid- and heat-resisting material projects into the body of the furnace, dividing the latter into two zones, each of which has a separate gas outlet. The top of this cylinder is closed with a bell hopper, through which coal may be fed as required, and is provided with a number of drip pipes for introducing the sludge acid. When coal is supplied to the furnace in sufficient quantity to maintain the upper level of the fuel bed within the cylinder, as shown in the illustration, a high-temperature zone is obtained in the lower fuel bed and a lower-temperature zone with the cylinder. The aqueous and tarry constituents of the sludge acid distill off during the passage of the acid through the low-temperature zone and pass to the tar condenser. The sulphuric acid vapors liberated in the high-temperature zone are collected in a separate condenser. Each condenser is provided with an exhaust fan for the removal of waste gases. (1,310,078; assigned to Chemical Construction Co.; July 15, 1919.)



FURNACE FOR CONTINUOUS DISTILLATION OF SLUDGE ACID

Cellulose-Nitrate Composition.—A mixture which is capable of producing a very flexible, transparent and uniform film is obtained by incorporating in 65 parts of acetone or methyl alcohol 10 parts of cellulose nitrate and 2 parts of butyl oxalate. HANS T. CLARKE of Rochester, N. Y., states that the butyl oxalate may be replaced by any dialkyl ester of oxalic acid in which each of the alkyl groups contains 4 or 5 carbon atoms. The plasticity and flexibility of the composition may be increased by the addition of softeners, such as amyl acetate, ethyl propionate, urea, castor oil, triphenyl phosphate, dibutyl sulphone, etc. (1,309,981; assigned to Eastman Kodak Co., July 15, 1919.)
Kodak Co., July 15, 1919.)

Personal

BRIG.-GEN. AMOS A. FRIES has been awarded the Distinguished Service Medal for exceptionally meritorious and distinguished services, officially set forth as follows: "As chief of the Chemical Warfare Service, he was charged with the important task of training and equipping our troops for a form of warfare in which the American Army had had no experience prior to the present war. Both in securing proper defensive measures against gas and in developing new methods for its use as an offensive agency, he performed his arduous duties with marked success, thereby rendering valuable services to the American Expeditionary Forces."

MR. CHESTER H. JONES, formerly a Captain in the Chemical Warfare Service, has joined the editorial staff of CHEMICAL & METALLURGICAL ENGINEERING. His headquarters will be at the Chicago office of the McGraw-Hill Co. in the Old Colony Building.

PROFS. H. R. MOODY and RESTON STEVENSON will return to the College of the City of New York in September. Dr. Moody was special expert with the War Industries Board and Dr. Stevenson served in France as Major in the Sanitary Corps.

MR. ELLWOOD HENDRICK, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING, has returned to New York after a month's trip to South America.

MAJOR MARION G. DONK of the Chemical Warfare Service, who was in charge of Government work on bromine production at the Dow Chemical Co. plant at Midland, Mich., has joined the staff of the Hercules Engineering Corporation.

LIEUT. CLIFFORD L. SNYDER, who has recently been discharged from the army, has joined the technical staff of the Detroit Testing Laboratory as sales engineer. Lieut. Snyder received his commission at Fort Sheridan, Illinois, and was later transferred to the Nitrate Division in charge of construction work at Plant No. 1, Sheffield, Ala.

Current Market Reports

The Non-Ferrous Metal Market

Monday, Aug. 11.—The non-ferrous metal market continues to be quiet, production is substantial and prices firm. Speculative buying is not so attractive as formerly.

Aluminum:—The market is quiet, 98-99 per cent ingots are now quoted at 33c. per lb. Scrap has declined; cast, 21-24c.; sheet, 22½-25c.; and clippings 23½-27c.

Antimony:—The market is easy, spot wholesale lots offering from 9⅛-9¼c. and jobbing lots, 9¼-9⅜c. per lb.

Copper:—Quotations have not changed. Spot 23-23½c. September futures, 24c.

Copper sheets, hot-rolled	lb.	33.50	—	......
Copper sheets, cold rolled	lb.	35.00	—	......
Copper bottoms	lb.	41.50	—	......
Copper rods	lb.	24.75	—	25.00
Copper wire	lb.	26.00	—	......
High brass wire and sheets	lb.	27.75	—	......
High brass rods	lb.	26.75	—	......
Low brass wire and sheets	lb.	30.50	—	......
Low brass rods	lb.	31.25	—	......
Brazed brass tubing	lb.	39.00	—	.....
Brazed bronze tubing	lb.	44.25	—	......
Seamless copper tubing	lb.	37.75	—	......
Seamless bronze tubing	lb.	44.25	—	......
Seamless brass tubing	lb.	36.00	—	......
Scrap, heavy machinery comp		18	—	19
Scrap, heavy and wire		18½	—	19½
Scrap, light and bottoms		13	—	16
Scrap, heavy, cut and crucible		20	—	21½
Scrap brass, heavy		9	—	12
Scrap brass, casting		13½	—	14
Scrap brass, light		10½	—	11½
Scrap, No. 1 clean brass turnings		11	—	11½
Scrap, No. 1 comp. turnings		16	—	17

Lead:—Lead continues quiet. New York quotations vary from 5¾-6c. East St. Louis, 5.3c. lb.

Tin:—Spot tin remains at 70c. with very few sales.

Zinc:—Spot spelter is offered at 7.60c. in New York and 7.25c. in East St. Louis.

OTHER METALS

Bismuth	lb.	$3.10 —	......
Cadmium	lb.	1.50 —	1.75
Cobalt	lb.	2.50 —	3.50
Magnesium	lb.	1.75 —	2.10
Mercury	75 lb.	109.00 —	......
Nickel	lb.	.41 —	.45
Iridium	oz.	175.00 —	......
Palladium	oz.	115.00 —	120.00
Platinum	oz.	105.00 —	110.00
Silver	oz.	1.12⅛—	......

The Iron and Steel Market

The monthly ingot report of the American Iron & Steel Institute shows that 2,508,176 gross tons of steel ingots were produced in July by 30 companies which in 1918 made 84.03 per cent of the industry's total ingot output. The indicated rate for the whole industry is 35,700,000 tons per annum, or 73 per cent of capacity, estimating capacity at 49,000,000 tons. Correspondingly June had shown 67 per cent, May 54 per cent and April 65 per cent. The figures indicate a dip to a rate of about 50 per cent at the middle of May, also to a rate of fully 75 per cent at the end of July, representing a gain of one-half in the rate in the short period of two and a half months. The year had opened up with production at about 87 per cent of capacity. Despite the wide fluctuation the rate in July and the average rate in the first half of the year were almost precisely the same, 72.3 per cent for the half-year and 72.9 per cent for July.

The Steel Corporation's unfilled obligations increased by 685,806 tons during July, this comparing with an increase of 610,545 tons in June, and decreases running quite uniformly, with an average of 640,000 tons a month, during the six months preceding, December to May inclusive. While the booking of actual shipping orders was heavy in June and July, particularly in July, the increase in the unfilled tonnage was of course due largely to the placing of contracts, as the monthly statement includes contract obligations. The total of such obligations at the end of July was 5,578,661 tons, equal to nearly six months of output, but the distribution as to products is such that in some lines a much longer period of time is represented and in other lines a much shorter period.

MARKET CONDITIONS IMPROVING

The steel market is no longer entirely one-sided. In April and the fore part of May there was nothing favorable. Orders were light, production was declining and prices were being shaded by many producers. In June there was improvement in all respects and in July the situation from all aspects was good, the various market indicia being wholly favorable.

Now the condition and prospects of the market present two sides. There is room for discussion. Until recently the fact that an order was placed was proof positive that the material was needed, and immediately, for actual consumption. Since several branches of the finished steel trade have become sold up, immediate delivery of such products is not assured and is in fact practically impossible, and a portion of the buying now in progress may perhaps rest not upon absolutely known and immediate requirements but rather upon the desire of the jobber or manufacturing consumer to protect his future.

The general industrial developments of the first half of August have been quite unfavorable to the iron and steel industry. The greatest lack the steel market has had has been railroad orders, and the demands railroad labor has lately made prevent any hope of there being an early decision as to the future status of the railroads whereby steel orders involved in upkeep and betterments could be placed. The obviously growing labor unrest affects the steel trade at another point. Its lack, besides that of railroad buying, has been in orders involved in large construction or investment undertakings, along which line there has been relatively little steel demand. The new developments as to labor are such as to make the general investor more conservative, and the outlook for steel orders involved in investment projects is distinctly less favorable than 30 days ago, whereas a continued improvement had been expected.

Prospects have greatly diminished that there will be any important advances in the near future in either pig iron or steel prices. Until very recently there were many predictions that an advancing market was a matter of the very near future. It is doubtful whether the market was directly in line for advancing prices through the operation of the law of supply and demand, and it may be that the steel producers who predicted price advances did so from adherence to the steel trade's traditional philosophy that the way to stimulate buying is to have an advancing market. The Steel Corporation, however, had allowed it to become known quite plainly a couple of months ago that it was positively opposed to steel price advances, this year at least, and while the independents who favored advancing prices may have thought for a time that the Steel Corporation's hand could be forced, the universal outcry over the high cost of living and the general recognition of the interdependence of all commodity price advances with wage advances make price advances, no matter in what commodity, very unpopular.

SOME FURNACES ADVANCE PRICES ON PIG IRON

The pig iron market is not to be judged finally by surface indications. The Alabama furnaces have advanced to the $26.75 price of March 21, placing them on a level, f.o.b. furnace, with many Northern furnaces when they have much freight to absorb to reach the limits of their usual distributing territory. Chicago district furnaces are reported to have advanced their prices $2 a ton, and two Cleveland producers have announced advances of 50c. These incidents are not proof of fundamental strength in the pig iron market, which sometimes exhibits signs of advancing because conditions are unfavorable, and sometimes declines because prospects have improved. The reason for such divergences from what would be regarded as reasonable conduct for a commodity market is that a furnace must either run or not run, while a short blast is expensive. The furnaces in operation are well sold and if conditions are not sufficiently promising to induce idle furnaces to blow in, the furnaces that are sold up may very naturally advance their asking prices. Merchant pig iron was produced at 10 per cent lower rate in July than in June, which easily accounts for there being far from a plethora of pig iron, but the July output was not over about 55 per cent of capacity, and in such circumstances a general and genuine advance in prices actually paid for pig iron is quite improbable, and it would be at the same time entirely without precedent. When there are many idle furnaces a marked improvement in the outlook induces idle furnaces to decide to get into blast, and such decisions are always followed promptly by the selling of "backlog" tonnages, frequently at more or less concessions from the going market.

EXPORT TRADE

The smallest iron and steel exports since 1915 fell in February of this year, 234,793 gross tons. Thereafter there was continued improvement until 544,580 tons were reported for June. Export demand has been moderately uniform for several months and the June tonnage is probably fairly representative of what is to be expected for some time to come. To compare exports with productive capacity it is of course necessary to eliminate scrap, pig iron, castings, etc., and when this is done it is seen that the steel exports of June were at the rate of a trifle less than 6,000,000 tons a year, on the finished rolled steel basis, capacity in which may be taken at 37,000,000 gross tons a year. Thus, referring only to steel, June exports represented about 16 per cent of capacity, or about 24 per cent of production, since the mills were operating at about 67 per cent during the month.

The best export year before the war was 1912, with about 2,400,000 tons of rolled steel or equivalent exported, that being about 11 per cent of the year's production, or about 10 per cent of the existing capacity. Thus exports have increased by about 150 per cent. To use definite figures, capacity may be said to have increased by 13,000,000 tons a year and exports by 3,600,000 tons.

The Chemical Market

New York, August 9, 1919.

Trading in heavy chemicals continues brisk for both domestic and export account, with *sodium bichromate* still holding the center of interest. Practically no changes in price in the general list have developed. An abrupt slump in the hitherto active vegetable oils, a sharp rise on the part of spirits of turpentine, with other naval stores in sympathy, complete the salient features of the local market during the past two weeks.

HEAVY CHEMICALS

With only one manufacturer making *sodium bichromate*, this chemical has risen from 11-12c. per lb. to 15-16c., although car lots are offered at 14½c. The consuming demand is still large, most of the export shipments going to England. Heavy sales of *potassium carbonate* made to manufacturers in the Middle West and to Denmark are reported at 17c. per lb.

Caustic soda is holding firm at the quotation established three weeks ago, while export orders show a slight diminution.

Iodine, resublimed, having advanced abroad, local dealers are asking 25c. more than the previous quotation of $4.25 per lb.

Better demand has led some manufacturers to advance *glycerine* 1c., making the present price 21c. per lb.

There has been a strike in the *phosphate* mining fields, particularly in Florida, for the past three months and this is still on. No phosphate has been shipped and it appears not likely that any will be for some time. *Phosphoric acid*, all *sodium phosphates*, *acid phosphates* and *fertilizers* are affected by the strike and are accordingly expected to rise.

COAL-TAR PRODUCTS

While there are no outstanding features among the coal-tar products, business in these items is on a firm footing with the increasing production of the textile mills gradually swelling the demand. Among the intermediates, aniline oil, aniline salts and dimethylaniline are being consumed in large volume. Following the advance in aniline oil recorded at the last writing, dimethylaniline has risen from the minimum quotation of 50c. to 52c. per lb. Quotations on *phenol* are nominal, pending the official announcement by the Government of the price at which its huge stock of this product is to be sold. Affected by this situation and the heavy demand, *salicylic acid*, U. S. P., is selling at 35-45c. per lb., the technical grade at 30-40c. per lb., in comparison with 30-35c. and 25-30c., respectively, two weeks ago.

VEGETABLE OILS

Vegetable oils are suffering a relapse from the active speculation of the past few months. The heavy buying from abroad has stopped abruptly as has the domestic. The present slump is attributable in the main to the instability of foreign exchange. The values of oils here have been augmenting while at the same time exchange has been declining. Buyers are between two fires and discreetly have withdrawn from the market. This condition is only temporary and within a short time satisfactory adjustments will be effected.

With the exception of cottonseed oil, there have been few changes in price on spot oil. Futures, however, dropped for a time, but are now back on the level and moving upward.

There have been serious losses of seed in some parts of the linseed-producing States. Until the new crop in November no improvement over present conditions is likely, especially as long as speculative interest is active. The trade is, therefore, awaiting developments while quotations remain unchanged.

NAVAL STORES

Two weeks ago spirits of turpentine was selling at $1.25-$1.27 per gal., which was a record figure. At this writing none is for sale in this market and it is nominally quoted at $1.75-$1.80. The market at Savannah is steadily advancing, having at present reached $1.71½ per gal. Both export and domestic buying have vied in vigor, the former having slightly the advantage. As a new feature, demand from Germany is reported increasing.

Likewise, stocks of rosins are exceedingly low — grades bringing fancy prices.

Emulating the naval stores market, pine oil, steam distilled, has advanced 17c. per gal. from the previous quotation of 78c.

St. Louis, August 5, 1919.

HEAVY CHEMICALS:—The outstanding development in the local market in the past two weeks has been the heavy demand for 60 per cent sulphuric acid and the strong market for nitric acid. The latter was expected to show a sharp decline about Aug. 1, when Government support was removed, but it has more than held its own.

The heavy demand for 60 per cent sulphuric acid has forced the price up 50 cents a ton and it is now averaging $12. The fertilizer people as usual are making the market and orders are coming in at such a rate that local producers are keeping busy.

The *66 per cent sulphuric acid* is quiet at $18 a ton. Business is good, especially if account is taken of slackness in steel-making, particularly marked at present in St. Louis, where many steel mills are running at low ebb.

Muriatic acid is quiet, 18 per cent selling for $22 in tank car lots. *Sodium bisulphate* (*niter cake*) has changed little since the last report. Local producers report the demand steady and all their production taken.

Nitric acid was expected to slump badly, but has more than held its own since the last report, two weeks ago. The 40 deg. Baumé is selling at 10 and 10½ cents a lb., 38 deg. at 9 cents, and 42 deg. at 11 cents.

Zinc chloride is very active and an advance in price is looked for. The 50 per cent sells at 4 cents a lb. in tank car lots, and some sales have been reported as low as 3¾ cents in spite of the advance of zinc.

Zinc oxide is reported strong by local producers. No price change has been made, but producers believe the persistent and heavy demand may force a rise. Prices remain at 8 to 9 cents a pound, according to lead sulphate content, in car lots and half a cent higher for smaller quantities.

Chicago, August 7, 1919.

In the main, the heavy chemical market is remaining firm, with almost the entire line in good demand, sodium bichromate still holding the local spot-light at a quotation of 15c. No fluctuation and no undue activity are apparent in the coal tar products, prices remaining the same. The pine tar line, however, is furnishing enough activity to make up for any lack of interest in other lines.

HEAVY CHEMICALS:—Sodium bichromate, on which a 4c advance was recorded on Aug. 1, is up 4½c more, to 15c a pound, with dealers having difficulty in supplying the demand. Potassium carbonate is being held at 19c with sales active. A quotation on yellow potassium prussiate of 68c is almost meaningless, as there is none to be had even at this figure. The red is also up 20c, $1.10 being the current quotation, with supply very limited.

The acids show no change on the local market. Although sales of sulphuric have fallen off to some extent, $18 a ton is still the quotation for 66-deg. With good demand, muriatic brings around $22. Activity in sodium bisulphate (niter cake) is not so pronounced, and no change in price has been recorded. Bleach, caustic soda and soda ash are all quoted at prices ruling for the past thirty days.

VEGETABLE OILS:—This market shows the effect of recent speculation, in that a decided slump has occurred in several items. Linseed oil remains at $2.48, with not much trading taking place. Soya bean oil and cocoanut oil are both off about two cents with holders of stock asking for bids. The quotation on bean oil to-day is 17c. Corn oil, and cottonseed oil both hold firm with fair demand.

FLOTATION OILS, NAVAL STORES:—No one seems able to forecast the future for turpentine, $1.65 being asked to-day and many sales being closed at that figure. The main question seems to be one of supplying the demand rather than one of price. It is freely predicted that without embargo turpentine will soon reach $2. Rosin also is up, W.W. bringing $25 and F $21.50. Pine tar and pine tar oil show no change.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, AUG. 9, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	......–......	$0.54 –$0.60
Acetone	lb.	$0.13½–......	.15 –......
Acid, acetic, 28 per cent	cwt.	2.75 – 3.00	3.00 – 3.25
Acetic, 56 per cent	cwt.	5.50 – 6.00	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00 –12.50	13.00 –13.50
Boric, crystals	lb.	.13 – .13½	.13½– .14
Boric, powder	lb.	.13 – .13½	.13½– .14
Hydrochloric, tech. 20 deg	cwt.	1.00 – 1.50	1.75 – 2.50
Hydrofluoric, 52 deg	lb.	.10 –......	.11 –......
Lactic, 44 per cent. tech	lb.	.11 – .14	.12 – .16
Lactic, 22 per cent. tech	lb.	.05 – .06	.05½– .07
Molybdic, C. P	lb.	......–......	6.50 – 7.40
Nitric, 40 deg	lb.	.06 – .06½	.07 – .08½
Nitric, 42 deg	lb.	.07 – .07½	.08 –......
Oxalic, crystals	lb.	.24 – .25	.25 – .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 –......	.10 – .14
Picric	lb.	.30 – .40	.50 –......
Pyrogallic, resublimed	lb.	......–......	......– 2.30
Sulphuric, 60 deg., tank cars	ton	12.00 –14.00	......–......
Sulphuric, 60 deg., drums	ton	17.00 –......	22.00 –......
Sulphuric, 60 deg., carboys	ton	20.00 –......	25.00 –......
Sulphuric, 66 deg., tank cars	ton	16.00 –18.00	23.00 –......
Sulphuric, 66 deg., drums	ton	20.00 –21.00	25.00 –26.00
Sulphuric, 66 deg., carboys	ton	25.00 –......	30.00 –40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	22.00 –......	27.00 –......
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 –......	32.00 –......
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 –......	35.00 –......
Tannic, U. S. P	lb.	......–......	1.30 – 1.40
Tannic (tech.)	lb.	......–......	.42 – .55
Tartaric, crystals	lb.	......–......	.84 – .86
Tungstic, per lb. of WO	lb.	......–......	1.20 – 1.40
Alcohol, Ethyl	gal.	4.00 –......	4.85 –......
Alcohol, Methyl	gal.	1.20 –......	1.23 –......
Alum, ammonia lump	lb.	.03½– .04½	.04½– .04½
Alum, potash lump	lb.	.08 – .09	.08½– .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½– .02	.02½– .02½
Aluminum sulphate, iron free	lb.	.02½– .03	.03½– .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 –......	.09 –......
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	......–......	.30 – .35
Ammonium carbonate, powder	lb.	.13 – .14	.14 – .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½– .13	.13½– .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 – .12½	.13 – .13½
Ammonium nitrate	lb.	.10 –......	.11 – .12
Ammonium sulphate	lb.	.05 –......	.06 –......
Amyl acetate	gal.	......–......	3.65 –......
Arsenic, oxide, lumps	lb.	......–......	.09 – .09½
Arsenic, sulphide, powdered	lb.	......–......	......–......
Barium chloride	ton	75.00 –80.00	85.00 –......
Barium dioxide (peroxide)	lb.	.22 –......	.24 –......
Barium nitrate	lb.	.10 – .10½	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.02½–......	.02½– .04
Bleaching powder (see calcium hypochlorite)		......–......	......–......
Blue Vitriol (see copper sulphate)		......–......	......–......
Borax (see sodium borate)		......–......	......–......
Brimstone (see sulphur, roll)		......–......	......–......
Bromine	lb.	......–......	.65 – .75
Calcium acetate	cwt.	2.00 – 2.05	2.10 –......
Calcium carbide	lb.	......–......	.04 – .05
Calcium chloride, fused, lump	ton	19.00 –25.00	30.00 –40.00
Calcium chloride, granulated	lb.	.01½– .01½	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	1.75 – 1.80	2.00 – 2.50
Calcium peroxide	lb.	......–......	1.50 – 1.70
Calcium phosphate, monobasic	lb.	......–......	.75 –......
Calcium sulphate, precipitated	lb.	......–......	.09 – .09½
Carbon bisulphide	lb.	.05½–	.06 – ....
Carbon tetrachloride, drums	lb.	.11 –......	.12 – .14
Carbonyl chloride (phosgene)	lb.	......–......	.75 –......
Caustic potash (see potassium hydroxide)		......–......	......–......
Caustic soda (see sodium hydroxide)		......–......	......–......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 –......	.08 –......
Cobalt oxide	lb.	......–......	1.60 – 1.65
Copperas (see iron sulphate)		......–......	......–......
Copper carbonate, green precipitate	lb.	......–......	.28 – .31
Copper cyanide	lb.	......–......	.65 – .70
Copper sulphate, crystals	lb.	.08½– .08½	.09 – .09½
Cream of tartar (see potassium bitartrate)		......–......	......–......
Epsom salt (see magnesium sulphate)		......–......	......–......
Formaldehyde, 40 per cent	lb.	......–......	.20 – .21
Glauber's salt (see sodium sulphate)		......–......	......–......
Glycerine	lb.	......–......	.20 – .21
Iodine, resublimed	lb.	......–......	4.50 –......
Iron oxide, red	lb.	......–......	.06 – .08
Iron sulphate, (copperas)	cwt.	1.00 –......	1.20 – 1.50
Lead acetate, normal	lb.	....	.12½– .14
Lead arsenate (paste)	lb.	......–......	.15 – .17
Lead nitrate, crystals	lb.	......–......	.85 – .86½
Litharge	lb.	......–......	.09½– .10½
Lithium Carbonate	lb.	......–......	1.50 –......
Magnesium carbonate, technical	lb.	......–......	.13 – .14½
Magnesium sulphate, U. S. P	100 lb.	2.00 – 2.63	2.75 –......
Magnesium sulphate	100 lb.	1.75 –......	2.00 –......
Nickel salt, double	lb.	.14 –......	.15 –......
Nickel salt, single	lb.	.12 –......	.15 – .16
Phosgene (see carbonyl chloride)		......–......	.70 –......
Phosphorus, red	lb.	......–......	.65 –......
Phosphorus, yellow	lb.	......–......	.35 – .37
Potassium bichromate	lb.	.25 – .28	.65 –......
Potassium bitartrate (cream of Tartar)	lb.	......–......	.55 – .60
Potassium bromide, granular	lb.	......–......	.49 – .50
Potassium carbonate, U. S. P	lb.	.60 –......	.65 – .70
Potassium carbonate, crude	lb.	.17 –......	.20 –......
Potassium chlorate, crystals	lb.	.24 –......	.27 – .30
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.32 –......	.35 – .40
Potassium iodide	lb.	......–......	3.55 – 3.60
Potassium nitrate	lb.	.19 –......	.21 –......
Potassium permanganate	lb.	......–......	.55 – .65
Potassium prussiate, red	lb.	......–......	.90 – 1.10
Potassium prussiate, yellow	lb.	......–......	.50 – .60
Potassium sulphate	ton	225.00 –......	......–......
Rochelle salts (see sodium potas, tartrate)		......–......	......–......
Salammoniac (see ammonium chloride)		......–......	......–......
Sal soda (see sodium carbonate)		......–......	......–......
Salt cake	ton	17.00 –18.00	......–......
Silver cyanide	oz.	......–......	1.19 –......
Silver nitrate	oz.	......–......	.67½– .68½
Soda ash, light	100 lb.	1.85 – 1.90	2.00 –......
Soda ash, dense	100 lb.	2.25 –......	2.50 –......
Sodium acetate	lb.	.06 – .07	.07 – .08
Sodium bicarbonate	100 lb.	2.35 –......	2.75 – 3.00
Sodium bichromate	lb.	.14½–......	.15 – .16
Sodium bisulphate (nitre cake)	ton	3.00 – 8.00	10.00 –......
Sodium bisulphite	cwt.	1.80 – 1.90	2.00 – 2.10
Sodium borate (borax)	lb.	.07½–......	.08 –......
Sodium carbonate (sal soda)	100 lb.	1.35 – 1.50	1.50 – 1.75
Sodium chlorate	lb.	.15 –......	.16 – .18½
Sodium cyanide	lb.	.30 –......	.31 – .34
Sodium fluoride	lb.	.13 –......	.14 – .15
Sodium hydroxide (caustic soda)	100 lb.	2.75 –......	2.90 – 3.50
Sodium molybdate	lb.	2.50 –......	3.25 –......
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.09½– .10	.10½– .13
Sodium peroxide, powdered	lb.	......–......	.30 – .32
Sodium phosphate, dibasic	lb.	.03½– .04½	.04 – .05
Sodium potassium tartrate (Rochelle salts)	lb.	......–......	43 – .45½
Sodium prussiate, yellow	lb.	.18 – .18½	.19 – .20
Sodium silicate, solution (40 deg.)	lb.	.01½– .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½–......	......– .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.05 – 1.35	1.50 – 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	......–......	.05 – .06
Sodium sulphite, crystals	lb.	.03½–......	.04 –......
Strontium nitrate, crystals	lb.	.25 –......	......– .28
Sulphur chloride	lb.	.05½–......	......– .06
Sulphur, crude	ton	35.00 –......	37.50 –......
Sulphur dioxide, liquid, cylinders	lb.	......–......	.10 – .12
Sulphur (sublimed), flowers	100 lb.	3.05 –......	......– 3.60
Sulphur, roll (brimstone)	100 lb.	2.70 –......	3.65 –......
Tin bichloride (stannous)	lb.	.48 –......	.49 – .50
Tin oxide	lb.	......–......	.60 –......
Zinc carbonate, precipitate	lb.	......–......	.20 –......
Zinc chloride, gran	lb.	.12½–......	.13½– .14
Zinc cyanide	lb.	.49 –......	.50 –......
Zinc dust	lb.	.09 – .11	.11 – .14
Zinc oxide, dry American	lb.	......–......	.10 – .13
Zinc sulphate	lb.	.03½–......	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.35	—	.50
Aniline oil, drums extra	lb.	.25	—	.30
Aniline salts	lb.	.28	—	.33
Anthracine, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.00	—	1.15
Benzidine, base	lb.	.95	—	1.15
Benzidine, sulphate	lb.	.90	—	1.10
Benzoic acid, U. S. P	lb.	1.00	—	1.10
Benzoate of soda, U. S. P	lb.	.95	—	1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.24	—	.28
Benzol, 90%, in drums (100 lb.)	gal.	.23½	—	.27
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	3.75	—	4.50
Beta naphthol, sublimed	lb.	.75	—	.80
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85	—	.90
Cresylic acid, 95-97%, dark, in drums	gal.	.80	—	.85
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.50	—	2.25
Dimethylaniline	lb.	.52	—	.57
Dinitrobenzol	lb.	.25	—	.37
Dinitroclorbenzol	lb.	.25	—	.28
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.30	—	.32
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.46
Diphenylamine	lb.	.70	—	.75
H-acid	lb.	1.75	—	2.25
Metaphenylenediamine	lb.	1.20	—	1.80
Monochlorbenzol	lb.	.10	—	.14
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.06½	—	.07½
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	.75	—	1.25
Nitrobenzol	lb.	.13	—	.15
Nitro-naphthaline	lb.	.35	—	.45
Nitro-toluol	lb.	.17	—	.20
Ortho-amidophenol	lb.	4.25	—	.....
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.90	—	1.00
Ortho-nitro-toluol	lb.	.27	—	.40
Ortho-toluidine	lb.	.30	—	.45
Para-amidophenol, base	lb.	2.60	—	3.50
Para-amidophenol, HCl	lb.	2.75	—	3.25
Para-dichlor-benzol	lb.	.06	—	.10
Paranitraniline	lb.	1.00	—	1.25
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.75	—	4.00
Paratoluidine	lb.	1.50	—	1.75
Phthalic anhydride	lb.	1.75	—	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10	—	.13
Pyridin	gal.	2.50	—	.....
Resorcin, technical	lb.	3.50	—	3.75
Resorcin, pure	lb.	6.50	—	7.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.30	—	.40
Salicylic acid, U. S. P	lb.	.35	—	.45
Salol	lb.	.80	—	.90
Solvent naphtha, water white, in drums, 100 gal.	gal.	.22	—	.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30

Tolidine	lb.	1.75	—	2.50
Toluidine, mixed	lb.	.45	—	.80
Toluol, in tank cars	gal.	.22	—	.24
Toluol, in drums	gal.	.23	—	.30
Xylidine, drums, 100 gal.	lb.	.44	—	.46
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal	gal.	.23	—	.27
Xylol, commercial, in tank cars	gal.	.22	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.44	—	$0.45
Beexwax, refined, yellow	lb.	.48	—	.49
Beeswax, white pure	lb.	.65	—	.68
Carnauba, No. 1	lb.	.88	—	.90
Carnauba, No. 2, regular	lb.	.65	—	.85
Carnauba, No. 3, North Country	lb.	.58	—	.60
Japan	lb.	.18½	—	.21
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	.....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.06	—	.06½
Paraffine waxes, refined, 118-120 m.p.	lb.	.07½	—	.08
Paraffine waxes, refined, 128-130 m.p.	lb.	.08½	—	.09
Paraffine waxes, refined, 133-135 m.p.	lb.	.10½	—	.11
Paraffine waxes, refined, 135-137 m.p.	lb.	.12	—	.13½
Stearic acid, single pressed	lb.	.25	—	.27
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.30	—	.33

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$0.95
Pine oil, pure, dest. dist.	gal.	.85
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, ref., sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.34
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.85
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.27
Pinewood creosote, ref.	gal.	.48

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$18.00	—	$18.25
Rosin E-I	280 lb.	18.50	—	20.50
Rosin K-N	280 lb.	21.00	—	24.50
Rosin W. G.-W. W.	280 lb.	23.50	—	25.50
Wood rosin, bbl.	280 lb.	17.70	—	18.00
Spirits of turpentine	gal.	1.75	—	1.80
Wood turpentine, steam dist.	gal.	1.65	—	.....
Wood turpentine, dest. dist.	gal.	1.55	—	.....
Pine tar pitch, bbl.	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	12.75	—	13.50
Retort tar, bbl.	280 lb.	13.75	—	14.50
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.90	—	1.07
Rosin oil, fourth run	gal.	.93	—	1.10

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.54	—	$0.54½
Upriver coarse	lb.	.31	—	.31½
Upriver caucho ball	lb.	.31	—	.31½
Plantation—First latex crepe	lb.	.41	—	.41½
Ribbed smoked sheets	lb.	.40	—	.40½
Brown crepe, thin, clean	lb.	.34	—	.36
Amber crepe No. 1	lb.	.36	—	.37

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.	lb.	$0.19	—	$0.20
Castor oil, AA, in bbls.	lb.	.21	—	.22
China wood oil, in bbls.	lb.	.22	—	.24
Cocoanut oil, Ceylon grade, in bbls.	lb.	.19½	—	.20
Cocoanut oil, Cochin grade, in bbls.	lb.	.21	—	.22
Corn oil, crude, in bbls.	lb.	.24	—	.25
Cottonseed oil, crude (f.o.b. mill)	lb.	.21	—	.25
Cottonseed oil, summer yellow	lb.	.28	—	.29
Cottonseed oil, winter yellow	lb.	.28	—	.30
Linseed oil, raw, car lots	gal.	2.20	—	2.22
Linseed oil, raw, tank cars	gal.	2.17	—	2.19
Linseed oil, boiled, car lots	gal.	2.24	—	2.25
Olive oil, commercial	gal.	2.30	—	2.50
Palm, Lagos	lb.	.17½	—	.18½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16½	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.26	—	.27
Peanut oil, refined, in bbls.	lb.	.29	—	.30
Rapeseed oil, refined in bbls.	gal.	1.55	—	1.60
Rapeseed oil, blown, in bbls.	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.19½	—	.20
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.16½	—	.17

FISH

Winter pressed Menhaden	gal.	$1.28	—	$1.35
Yellow bleached Menhaden	gal.	1.30	—	1.37
White bleached Menhaden	gal.	1.32	—	1.38
Blown Menhaden	gal.	1.38	—	1.40

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00	—	$36.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	35.00	—	47.50
Casein	lb.	.16	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	11.50	—	15.50
Fluorspar, acid grade, lump, f.o.b. mines	net ton	$30.00	—	$35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	30.00	—	40.00
Fuller's earth, imported, powdered	ton	.....	—	.....
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	1.10	—	.....
Shellac, D. C.	lb.	.....	—	.....
Shellac, V. S. O.	lb.	.....	—	.....
Shellac, Diamond I.	lb.	.....	—	.....
Shellac, orange, fine	lb.	.....	—	.....
Shellac, orange, superfine	lb.	1.25	—	.....
Shellac, A.C. garnet	lb.	.95	—	.....
Shellac, bleached, bone dry	lb.	1.40	—	.....
Shellac, bleached, fresh ground	lb.	1.10	—	.....
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	55.00	—	60.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	90-100 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	net ton	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$250.00	—	.....
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.30	—	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70	—	.....
Ferro-manganese, 70-80% Mn	gross ton	100.00	—	125.00
Spiegeleisen, 16-20% Mn	gross ton	30.00	—	50.00
Ferro-molydenum, per lb. of Mo	lb.	1.85	—	2.00
Ferro-silicon, 50%	gross ton	85.00	—	115.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.30	—	1.60
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Resales and overstocks make above prices approximate.

Ores and Semi-finished Products

Chrome ore, 35-40%, $C_2.O_3$	unit	$0.60	—	
Chrome ore, 48% and over	unit	.80	—	
Coke, foundry, f.o.b. ovens	net ton	5.50	—	$6.00
Coke, furnace, f.o.b. ovens	net ton	4.00	—	5.00
Petroleum coke, refinery, Atlantic seaboard	net ton	11.50	—	12.00
Fluorspar, gravel, f.o.b. mines	net ton	20.00	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.65
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over per unit of WO_3	unit	9.00	—	12.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	10.00
Uranium oxide, 96%	lb.	.....	—	.....
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.15	—	.....
Pyrites, foreign, fine	unit	.15	—	.....
Pyrites, domestic, fine	unit	.14	—	.17½
Ilmenite, 50% TiO_2	net ton	30.00	—	.....
Rutile, 95% TiO_2	net ton	200.00	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00

Resales and overstocks make above prices approximate.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container 300	bbl.	2.65
Common brick, at dock	M.	15.00
Hollow building tile, At factory, Perth Amboy, N. J. } 8x12x12	M.	194.40
Hollow building tile, At factory, Perth Amboy, N. J. } 12x12x12	M.	291.60
Yellow pine, 3x4 to 8x8, 20-24 ft. long	M.	40.00
Yellow pine, 3x4 to 8x8, 20-24 ft. long at Chicago	M.	39.50
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis	M.	37.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	60.00
Roofings, tar pitch (in 400-lb. bbl.)	ton	21.00
Roofings, asphalt pitch	ton	34.00
Roofings, asphalt felt	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft.		2.00
Roofings, slate-finished shingles, 100 sq.ft.		5.00
Linseed oil, raw in barrels	gal.	2.15
Linseed oil, 5 gal. cans	gal.	2.28
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

JOHNSON—The Mines & Development Corp. has taken over the Arizona-Michigan property here and plans to improve same and also build a 50-ton concentrator.

California

REDLANDS—The University of Redlands has awarded the contract for the construction of a 2-story, 60 x 120-ft. Science Hall, including laboratories, etc., to W. C. Crowell, 440 Chamber of Commerce Bldg., Pasadena.

Connecticut

HARTFORD — The Hartford Rubber Works, Bartholomew Ave., plans to erect a 6-story, 100 x 300-ft. addition to its factory. Lockwood, Greene & Co., 60 Federal St., Boston, Mass., engineer.

MANCHESTER—The Orford Soap Co., Hilliard St., plans to build a factory addition, including a grinding mill. Estimated cost, $40,000.

STAMFORD—The city plans to build a sewage disposal plant. Estimated cost, $225,000.

STRATFORD—The city has awarded the contract for the construction of a sewage disposal plant, chlorine-treatment house, tidal basin, sludge bed, etc., to the Eastern Engineering & Construction Co., 886 Main St., Bridgeport. Estimated cost, $175,000.

Kansas

GALENA—The Silver Fox Lead & Zinc Co. plans to build a new mill to replace the one destroyed by fire on June 29 and is in the market for entire concentrating plant equipment. F. Childress, general manager.

Maryland

TOWSON—The Commissioners of Baltimore County will receive bids until Aug. 18 for the construction of a sewage disposal plant, Imhoff tanks, dosing chamber, trickling filters, etc. Estimated cost, $100,000. Norton, Bird & Whitman, 606 Munsey Bldg., Baltimore, engineers.

Massachusetts

PROVINCETOWN — The East Harbor Fertilizer Co., 293 Bridge St., Springfield, plans to construct a 2-story, 70 x 75-ft. fertilizer plant. Estimated cost, $30,000. C. N. Flagg Co., Springfield, engineer.

WILLIMANSETT (Holyoke P. O.)—The Paper Makers Chemical Co., 529 Main St., has awarded the contract for the construction of a 1-story factory, to P. J. Kennedy & Co., Inc., 464 Maple St., Holyoke. Estimated cost, $75,000.

Michigan

DETROIT—The city plans to construct the Conners Creek sewerage system on Conners Rd.; treatment works to comprise a battery of 40 Imhoff tanks. Estimated cost, $14,000,000. C. W. Hubbell, City Hall, engineer.

DETROIT—The Fisher Body Corp., Piquette Ave., has awarded the contract for the construction of a 6-story, 156 x 581-ft. paint shop on Piquette Ave and St. Antoine St., to H. G. Christman Co., 315 Stevens Bldg. Estimated cost, $1,200,000. Noted Aug. 1.

Minnesota

ADRIAN—The city is having surveys made by Druar & Smith, engineers, Globe Bldg., St. Paul, for the construction of a new sewerage system and a disposal tank. Estimated cost, $40,000. M. E. Corrigan, village clerk.

AITKIN—L. Hallem, city commissioner, is receiving bids for installing one purifier, one water filter, one 150-hp. Corliss type steam engine, one electric generator, 125 kw. current, one coal conveyor and 50,000-gal. steel or wood water tank.

ROCHESTER—F. A. Bricker and G. J. Pattison, Fargo, N. D., and A. C. Fawcet, Rochester, plan to build a 5-story, 46 x 142-ft. dental clinic. Estimated cost, $300,000.

Missouri

CAMERON—The city will soon award the contract for the construction of a filtration plant. Estimated cost, $35,000. E. E. Harper, 2408 East 30th St., Kansas City, engineer. Noted May 15.

DUENWEG—The M. & T. Mining Co. plans to move its mill from Granby District and erect same here, and is in the market for boiler, steam engine and compressor rolls. R. McGee, general manager.

MILAN—The city will soon award the contract for the construction of complete sanitary sewers and a disposal plant Estimated cost, $40,000. Archer & Stevens, New England Bldg., Kansas City, engineers.

ST. LOUIS—The American Syrup Preserving Co., East Union Ave. and Terminal R. R., has awarded the contract for the construction of a 1-story, 55 x 70-ft. factory at 5125 Penrose Park, to B. J. Charleville, 810 Chestnut St. Estimated cost, $5000.

Montana

HELENA—The State Board of Health plans to build a laboratory. Estimated cost, $50,000.

SCOBEY—The City Council will soon award the contract for the construction of sanitary sewers, manholes, settling tank and sludge beds. Estimated cost, $45,000. W. B. Sanders, Helena, engineer.

Nebraska

HARVARD—The city plans to construct sanitary sewers and a sewage disposal plant. Estimated cost, $50,000. Grant, Fulton & Letton, 505 Bankers' Life Bldg., Lincoln, engineers.

New Jersey

NEWARK—The Max Hertz Leather Co is having plans prepared for the construction of a 3-story, 42 x 200-ft. factory addition on Oliver St. Estimated cost, $150,000. James A. Pigott, 9 Clinton St., engineer.

NEWARK—The Radell Leather Co. has had plans prepared for the construction of a 1-story, 50 x 60-ft. factory addition on Wilson Ave. Estimated cost, $10,000. J. A. Pigott, 9 Clinton St., engineer.

PLEASANTVILLE—The city has awarded the contract for the construction of a sanitary sewerage system, to Edwin G. Britz, 1759 Park Ave., New York City. Estimated cost, $86,310.

TRENTON—The Albano Manufacturing Co., manufacturer of shoe paste, 701 Cass St., has awarded the contract for the construction of a 1-story, 50 x 90-ft. factory, on Oakland Ave., to Samuel Tietz, 469 Brunswick Ave. Estimated cost, $14,890. Noted July 1.

TRENTON—The Trenton Electric & Conduit Co., 3 Tyler St., plans to construct a 2-story plant for the manufacture of porcelain. Estimated cost, $10,000.

WESTMONT—The city has awarded the contract for the construction of a 9-mile sanitary sewerage system, etc., to W. Penn Corson, 1141 Sycamore St., Camden, at $68,416. Noted July 1.

New York

KINGS PARK—The State Hospital Commission, Capitol, Albany, received bids for the construction of a sewage disposal plant, at Kings Park State Hospital, from Ganford Co., Inc., 503 5th Ave., $8,320; New York Sewage Disposal Co., 37 East 28th St., $8,650; Slattery Engineering & Construction Co., Inc., 7 East 42nd St., $10,799; contractors all of New York City. Noted Aug. 1.

SYRACUSE—The Board of Education of Onondaga plans to erect a 2-story, 150 x 200-ft. school. A chemical laboratory will be installed in same. Estimated cost, $350,000. Ford, Buck & Sheldon, 68 Prospect St., Hartford, Conn., engineers.

SYRACUSE—The N. L. Oberdorfer Brass Co., 804 East Water St., will receive bids until Aug. 25 for the construction of a 1-story brass foundry on Water St. Estimated cost, $40,000. Melvin L. King, Snow Bldg., engineer.

WEST ENDICOTT (Endicott P. O.)—The Endicott Johnson Co., Johnson City, plans to erect a 3-story concrete tannery and a 4-story concrete shoe factory at West Endicott. Estimated cost, $350,000.

Ohio

ALLIANCE—The city will hold an election Sept. 8, to vote on $525,000 bonds for the erection of a gas plant.

CLEVELAND—The Atlantic Foundry Co., 7510 Morgan Rd., has awarded the contract for the construction of a 1-story, 26 x 36-ft. addition, to Bolton & Pratt Co., 801 Columbia Bldg. Estimated cost, $5000. Noted Aug. 1.

CLEVELAND — The Cleveland Fruit Juice Co., 1390 West 9th St., plans to build a 3-story, 100 x 140-ft. factory on Euclid Ave. and London Rd. Estimated cost, $80,000.

CLEVELAND—The Cuyahoga Galvanizing Co., 1280 East 59th St., plans to construct a 1-story, 60 x 100-ft. factory at 3352 Payne Ave. Estimated cost, $10,000.

CLEVELAND—The Glidden Varnish Co., Madison Ave. and Berea Rd., is having plans prepared for the construction of a 4-story 59 x 90-ft. grinding building on Madison Ave. Estimated cost, $60,000. Osborn Engineering Co., 2848 Prospect Ave., engineer.

CLEVELAND—The Orth Brass & Aluminum Castings Co., 1378 East 33rd St., plans to build a 2-story, 34 x 78-ft factory. Estimated cost, $10,000.

TOLEDO—The City Council is having plans prepared for the installation of twenty-two new filters of 1,000,000-gal. daily capacity, a 20 x 150 x 500-ft. settling basin of 11,250,000-gal. capacity and several miles of 30, 32 and 40 in. C. I. mains. Bonds for $850,000 have been voted for project. H. C. McClure, 229 Valentine Bldg., engineer.

Oklahoma

DOUTHAT—The Dudley Milling Co. plans to erect a tailing mill to treat tailings from Admiralty No. 2 and is in the market for a gas engine, rolls, jig-irons, elevator pulleys and belts. C. Theuer, supt.

EL RENO—The City Clerk will soon receive bids for enlarging the sewerage system and Imhoff sewage disposal plant. Estimated cost, $95,000. H. G. Powel, Box 204, engineer.

HARTSHORNE—The city plans an election Sept. 2 to vote on bonds for the construction of a water purification plant. V. V. Long & Co., Oklahoma City, consulting engineer.

HOCKERVILLE—The Hope Lead & Zinc Co. plans to move the old Scott Eagle Mill from Quapaw and erect same here, and is in the market for gas engines, compressor and tables. W. Benton, supt.

PICHER—W. & H. Logan & Co., Hockerville, plans to move the old Coronet Mill from north of Blue Mound to Picher, and is in the market for tables, rolls, shafting, pulleys and belting. F. Sleck, general manager.

ST. LOUIS—The Underwriters Land Co., Picher, plans to erect a complete new concentrating plant at their No. 4 shaft, and is in the market for entire equipment for same. F. N. Bendelari, general manager.

STROUD—The city is having plans prepared by Johnson & Benham, engineers, Firestone Bldg., Kansas City, Mo., for laying 28,000 ft. of sewers and installing Imhoff tank. Estimated cost, $95,000

Oregon

BEND—The Oregon Nitrate Co. plans to develop Stinking Lake and Sheep Mountain nitrate deposits by installing crystallization evaporating system and crushing plant. Estimated cost, $25,000. J. H. Morgan, Bend, president.

Pennsylvania

FARMERVILLE—Morris Knowles, engineer, Jones-Law Bldg., Pittsburgh, has awarded the contract for the construction of a sewage disposal plant for the Consumers Mining Co., to Pihl & Miller, Wabash Bldg. Estimated cost, $10,000. Imhoff tanks will be installed in same.

PHILADELPHIA—The Philadelphia Paper Manufacturing Co., 231 South Front St., has awarded the contract for the construction of a 1-story, 55 x 192-ft. factory on Nixon and Fountain Sts., to the Brown Construction Co., 4600 Main St. Estimated cost, $25,000.

PHILADELPHIA—Powers, Weightman & Rosengarten Co., 916 Parrish St., has awarded the contract for the construction of a 5-story chemical factory, to R. C. Ballinger & Co., 218 North 13th St. Estimated cost, $45,000.

PITTSBURGH—The United Engineering & Foundry Co. is having preliminary plans made for the construction of a 2-story, 45 x 100-ft. foundry and office buildings on 54th St. Hunting-Dans Co., Century Bldg., architect.

SCRANTON—The Heath Silk Co. plans to construct a 3-story, 50 x 100-ft. silk mill on Wyoming Ave. Estimated cost, $66,000. G. N. Edson, Connell Bldg., architect.

Rhode Island

PAWTUCKET—The Halliwell Co., Blackstone Ave., has awarded the contract for the construction of a 2-story, 60 x 105-ft. addition to its bleachery, to the Cruise & Smiley Construction Co., 188 Main St. Estimated cost, $40,000.

PROVIDENCE—The U. S. Gutta Percha Co., 12 Dudley St., has awarded the contract for the construction of a 5-story, 50 x 100-ft. steel addition to its plant, to Williams & Merchant, Inc., 86 Weybosset St. Estimated cost, $80,000.

EL PASO—The city plans an election to vote on $100,000 bonds for the construction of a septic tank.

STRAWN—The Palo Pinto Oil Co., 61 Broadway, New York City, has awarded the contract for the construction of a gasoline extraction plant to Westinghouse, Church, Kerr & Co., 37 Wall St., New York City. Estimated cost, $50,000.

Utah

SALT LAKE CITY—Headlund & Kent, engineers, Dooley Bldg., will soon award the contract for the construction of a 10-ton oil distilling plant for the Rainbow Petroleum Oil Products Co. Estimated cost, $25,000.

Washington

SPOKANE—The Shell Oil Co., of California, North 111 Green St., plans to enlarge its plant here. Estimated cost, $100,000.

SPOKANE—The Spokane Drug Co., 707 Railroad Ave., plans to build a 5-story, 116 x 142-ft. drug factory on Wall St. and Railroad Ave. Estimated cost, $200,000.

West Virginia

PARKERSBURG—The city has awarded the contract for the construction of a crib filter at the filtration plant, to the Western Rivers Co., Point Pleasant. Estimated cost, $20,545. The city will furnish necessary cast iron pipe.

Ontario

BRANTFORD—The Brantford Smelting Co. has awarded the contract for the construction of a 100 x 200-ft. tin smelting plant, to P. H. Secord, 133 Nelson Ave. Estimated cost, $50,000.

KINGSTON—The Department of Public Works, Ottawa, has awarded the contract for the construction of a sewage system and disposal works at the Sydenham Military Hospital, to W. H. Harvey, Kingston. Estimated cost, $10,403.

KITCHENER—The Canadian Consolidated Rubber Co., 137 King St., plans to construct a 4-story rubber factory at 149 Strange St. Estimated cost, $1,000,000.

LONDON—C. S. Hyman Co., Ltd., Richmond St., will soon award the contract for the construction of a 5-story, 150 x 300-ft. tannery on St. George St. Estimated cost, $800,000. H. C. McBride, Molsons Bank, architect. Noted July 15.

LONDON—The McClary Manufacturing Co., 383 Wellington St., manufacturer of enamelware, tinware, etc., plans to build a 5-story, 72 x 120-ft. addition to its factory. Estimated cost, $60,000. J. M. Moore, 425 Richmond St., architect.

SAULT STE. MARIE—The Algoma Steel Co. plans to build a 1-story structural steel plant. Estimated cost, $300,000.

WINDSOR—The city has had plans prepared by F. W. Thorold, engineer, 167 Avenue Rd., Toronto, for the construction of a pumping station and filtration plant for the border cities of Windsor, Sandwich, Walkerville, etc. Estimated cost, $100,000.

Cuba

HAVANA—The Air Reduction Co., 120 Broadway, New York City, has awarded the contract for the construction of a 2-story, 98 x 108-ft. acetylene plant, to Hamilton & Chambers, 29 Broadway, New York City. Estimated cost, $100,000.

Coming Meetings and Events

THE AMERICAN CERAMIC SOCIETY will hold a meeting in Chicago, Sept. 24.

THE AMERICAN CHEMICAL SOCIETY will hold its Fall meeting in Philadelphia, Pa., Sept. 2-6 inclusive.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its Fall meeting in Chicago, Sept. 23-25 inclusive.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1919 convention in Philadelphia, Sept. 29 to Oct. 4.

THE AMERICAN GAS ASSOCIATION will hold its annual convention and exhibition of gas appliances and apparatus at the Hotel Pennsylvania, New York, Oct. 13 to 18.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its Fall meeting in Chicago, Ill., Sept. 22-27.

THE AMERICAN STEEL TREATERS' SOCIETY will hold its first annual convention in Chicago, Ill., Sept. 22-27.

THE FIFTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in Chicago, Ill., Sept. 22-27 inclusive.

THE INSTITUTE OF METALS DIVISION of the A. I. M. E. will hold its next meeting in Philadelphia, Pa., Sept. 29 to Oct. 4.

THE INSTITUTE OF METALS will hold its Autumn meeting in Sheffield, England, Sept. 24-25.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its Fall meeting in Chicago from Sept. 24 to 27.

Industrial Notes

THE MCGRAW-HILL BOOK CO. celebrated its 10th anniversary on July 1, 1919, and issued a booklet entitled "10 Years." For over 20 years prior to July 1, 1909, the Book Department in the McGraw Publishing Co. and the Hill Publishing Co. has been producing books in very special fields. The consolidation has resulted in "better books in text and manufacture," as well as in greatly increased prestige and service. From 200 titles 10 years ago, the list has grown to approximately 1000. Sales during the war were unusually large owing to the demand for highly specialized engineering books. Under special contracts with the Navy Department the Company produced 20 new texts for the aviation and submarine sections. For the Khaki University 1500 packing cases containing 150,000 books were shipped overseas.

THE SOCIETE DE VALEURS POUR FERS ET ACIER (Society for Values of Iron and Steel) in Schaffhausen, Switzerland, reports Consul General L. J. Keena at Zurich has established in Zurich a metallurgical exchange, the purpose of which is to bring together every Friday buyers and sellers of machines of every description and of all kinds of metals used in the manufacture of machinery. The exchange solicits the membership of foreign engineers and exporters of raw materials and calls particular notice to the advantages which a foreign member will have in the marketing of his products in Switzerland by visiting the exchange and bringing his business to the attention of manufacturers desiring to import. The fee for such membership is $5 a year.

ARTHUR D. LITTLE, INC., Cambridge, Mass., announces the resignation of vice-president Mr. Harry S. Mork, who has been elected to the vice-presidency of the Lustron Co. of Boston. This concern manufactures artificial silk by a process developed in the Little Laboratories.

THE PORTABLE MACHINERY CO., Passaic, N. J., has issued a circular entitled "We Welcome Fair Competition." It briefly describes how one concern has kept and is trying to market an imitation of the Scoop conveyor. A suit is pending for infringement of rights and purchasers are warned against the imitation.

THE ELECTRIC FURNACE CONSTRUCTION Co., Finance Bldg., Philadelphia, Pa., has received orders for Greaves-Etchells electric furnaces from the Sullivan Machinery Co. and the Imperial Japanese Mint; the latter is for the manufacture of coinage bronze.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., has opened offices at 905 Kresge Bldg., Detroit, Michigan. Mr. H. S. Kinsley is in charge and has taken with him from the Chicago office Messrs. C. W. Greenman and M. Dugliss, both of whom were recently mustered out of the service.

THE CHICAGO PNEUMATIC TOOL CO., Chicago, Ill., announces the appointment of Mr. N. S. Thulin as special railroad representative on the staff of Mr. S. C Sprague, manager of Western railroad sales. It is also announced that the Minneapolis office of this company will move to Fifth Avenue and Fifth Street South.

Stocks and Bonds

Closing Bid and Asked Quotations Aug. 13, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am.Ag.Ch....	102	102[illegible]	Mat.Al.Wk..	31	33
do.pf......	98	100	Ten. C. & C.	13[illegible]	14
Barrett Co...	120	122	Un. Dyewood	...	...
do.pf......	110	114[illegible]	do.pf......	...	...
Gen. Chem...	170	190	Va.-Car.Ch...	82[illegible]	82[illegible]
do.pf......	103	107[illegible]	do.pf......	113	114
Int.Ag.Ch....	29	29[illegible]			
do.pf......	84[illegible]	85[illegible]			

Bonds

	Bid	Ask
Am. Ag. Ch., 1st cv. 5s, '28..............	93	110
Am. Ag. Ch., cv. db. 5s, '24..............	103	109[illegible]
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32....	84	84[illegible]
Va.-Car. Ch., 1 mtg. 5s, '23..............	95[illegible]	95[illegible]
Va.-Car. Ch., cv.db. 6s, '24..............	102[illegible]	103

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co..	80	92	P-A Pet & Tr	109[illegible]	109[illegible]
Cal. Pet......	47	47[illegible]	do. pf......	...	...
do. pf......	83[illegible]	84	Pierce Oil....	21[illegible]	21[illegible]
Col. G. & E..	59[illegible]	59[illegible]	Royal Dutch.	89[illegible]	90
Mex. Pet.....	176[illegible]	177[illegible]	Sinclair O&R.	55[illegible]	56
do. pf......	107	115	Texas Co....	255	258
Ohio Cit. Gas.	53[illegible]	53[illegible]	Tex. Pac. Ld.		
do. pf......	...	....	Tr........	360	465
Ohio Fuel S...	51	51[illegible]	Tidewater Oil	240	245
Okla. P. & R.	10[illegible]	10[illegible]			

Bonds

	Bid	Ask
Columbia Gas & Electric, 1 5s, '27......	90[illegible]	90[illegible]
Col. G. & El., std. 1 5s, '27..............	90[illegible]	90[illegible]
Pan-Am. Pet. & Tr. 1 6s, '19-'27..........	130	....
Pierce Oil, cv. db. 6s, '24................	104[illegible]	105
Pierce Oil, cv. 5% Notes, '20..............	105[illegible]	120
Sin. O. & R. 1 ln. 7s, '20, with stk. war...	...	...
Sin. O. & R. 1 ln. 7s, '20 without stk war.	...	...
Texas Co., db. 6s, '31....................	102[illegible]	103
Union Oil of Cal. 1 5s, '31................	94[illegible]	95
United Fuel Gas 1 mtg. 6s, ser. A., '36...	94[illegible]	98

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F....	42[illegible]	43	Pitts. Ste. pf.	95	97
Beth. Steel...	84	86[illegible]	Rep. Iron &		
do. class B..	86[illegible]	86[illegible]	Steel......	88[illegible]	89
do. pf., 8%.	112[illegible]	114	do. pf.....	104[illegible]	105
do. pf., 7%.	106	109	Sloss Sheff. I.		
Central Fdry.	35[illegible]	36	& S.......	64	64[illegible]
do. pf......	65	68[illegible]	do. pf.....	88	92
Col. F. & I...	45	45[illegible]	Superior Steel	39[illegible]	41
do. pf......	...	...	do. 1 pf....	105	...
Cruc. Steel...	36[illegible]	37	Trans. & W.		
do. pf......	...	...	Steel......	58	59
Great No. Ore	43[illegible]	44	Un. Alloy St.	51	52
Gulf Sta. Steel	59	61	U.S.C.I.P.&F.	35	35[illegible]
do. 1 pf.....	94	98	do. pf.....	67	70
Lack. Steel...	81	81[illegible]	U. S. Steel...	103[illegible]	103[illegible]
Mid.St.&Ord..	51	51[illegible]	do. pf.....	115	115[illegible]
Nova Scotia			Va. Coal,I&C	61	64
Steel.......	78	81			

Bonds

	Bid	Ask
Beth. Steel, 1 ext. gtd. S.F. 5s, '26.......	96	96[illegible]
Beth. Steel, 1 ln. ref. 5s, Ser. A, '42.....	...	88[illegible]
Beth. Steel, P. M. & I. S. F. 5s, '36......	85[illegible]	85[illegible]
Buff & Susq. Iron, 1 S. F. 5s, '32.........	90	93[illegible]
Buff & Susq. Iron, deb. 5s, '27............	...	....
Cent. Found, 1 mtg. S. F. 6s, '21..........	85	88[illegible]
Col. F. & I., gn. S. F. 5s, '43............	90[illegible]	92
Ill. Steel, db. 4[illegible]s, '40...........	84[illegible]	84[illegible]
Ind. Steel, 1 mtg. gtd. 5s, '52............	95[illegible]	96[illegible]
Lack. Steel, 1 5s, '23.....................	96[illegible]	98
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50.	93[illegible]	95
Mid. St. & Ord., clt. cv. S. F., 5s, '36....	87	88
Nat. Tube, 1 mtg. gtd. 5s, '52.............	94	96[illegible]
Rep. I. & S., S. F. mtg., 5s, '40..........	93[illegible]	93[illegible]
Tenn. C. & I. R.R. 'gn. 5s, '51............	90	...
U. S. Steel, S. F. 5s, 63..................	100[illegible]	100[illegible]
Va. C., I.& C. 1 5s, '49...................	84	85[illegible]

Published SEMI-MONTHLY *on the* FIRST *and* FIFTEENTH *of each month*

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, September 1, 1919 *Number* 5

Fifth National Exposition Of Chemical Industries

IN THE last week in September chemistry moves to Chicago, along with the National Exposition of Chemical Industries. This will be the fifth of the kind and it bids fair to outstep all previous efforts.

The value of these expositions has been proved many times, and many things have been learned both by the management and by exhibitors. For instance, it is not profitable to draw a crowd just to show something unusual. The rubberneck is not a purchasing organism. On the other hand, whenever a betterment or economy is made clear and evident to the understanding mind, it brings immediate response and inquiry. In other words, the Exhibition is one of applied technology, and not a demonstration in popular science. As an inducement to fond mothers to bring along their little Reginalds and Harolds, with a view to persuading them to study science and become great chemists, the show does not even attempt to function. To the chemical engineer it grows more interesting every year. To the—we may almost say millions of collectors of advertising catalogues who seem to visit every exposition to improve their minds by walking over miles of floor space, we are glad to say it bids less and less encouragement as the years roll on.

Jointly with the first Exposition was held the annual meeting of the American Electrochemical Society, and it was a great success. The following year the American Chemical Society as well as its Electrochemical cousin had an annual meeting during the Exposition. This proved too much of a good thing, for it was beyond physical endurance to be present at the many sessions that almost commanded attendance. The following year there were no meetings except the important symposia which constitute a daily feature. This year, with the exception of the American Chemical Society, the time is to be embellished with annual meetings of five important organizations: The American Electrochemical Society, the Technical Association of Pulp and Paper Manufacturers, the American Steel Treaters' Society, the American Mining and Metallurgical Engineers and the American Ceramic Society, which will all meet in conjunction with the show. And there are to be symposia and discussions and, as likely as not, manifestoes and declarations.

The program which we give in a special insert for the convenience of our readers is very elaborate and replete with interest. It should not be forgotten that the Exposition is going on at full tilt during all these frequent intellectual and occasional gustatory festivities. The list includes the various general and sectional meetings of the societies named with the exception of those of the American Ceramic Society, which are not fully determined upon the time of our going to press. In addition to these and the meetings arranged for by the management of the Exposition, there will occur on Friday, the 26th inst., an event of historic interest; consisting in the award of the Willard Gibbs medal by the Chicago Section of the American Chemical Society to Professor W. A. NOYES.

The whole occasion is planned on a large scale, and we are heartened by the fact that, as our people begin to see the incidence of chemistry upon industry on every hand, they are getting the opportunity to learn how it touches them.

The management spends some 51 diligent weeks every year in getting the Exposition together and arranging the details. The result is a very concentrated show which technical chemists can ill afford to miss.

Shabby Treatment of Patent Examiners

THE Commissioner of Patents testified before the House Committee on Patents last month that resignations from his staff had increased from about 8 per cent in 1915-16 to over 25 per cent per annum in 1918-19. And under date of Aug. 26 the Civil Service Commission announces examinations to be held for "Patent Investigator (Male) $1200 to $1800 a year." For those having had the necessary preliminary instruction and three years' experience the opportunity is also offered to advance to "Expert Patent Investigators at $1800 to $2400 a year."

This reminds us of a picture lately printed, of a man applying for a position. The prospective employer declares that they require two years' post-graduate work and five years' professional practice and that the salary is $1800 a year. The applicant says, "Say, Boss, I ain't never had no education," to which the employer replies, "Oh, excuse me! Welcome to our works. Your wages will be $7 a day. Come with me."

The service affords excellent training for men who want to become patent solicitors and attorneys, but we are not short of patent attorneys. There are enough of them to take care of the business offered. On the other hand there is a serious shortage of good examiners. The salaries paid do not make the posts attractive except to those who intend to enter legal practice, and these may be expected to leave as soon as they feel themselves capable. From an economical standpoint a young man stands as good if not a better chance if he goes "braking" on a railroad. Of course he would miss the pleasant living conditions and delightful society that Washington offers when the stress of war is raised, but this applies particularly to applicants of a gregarious nature. Many are not. And if the applicant regards the salary of $100 a month as good pay—it being nearly the price of unskilled labor with steady work—it may be that he lacks the natural gifts to be a good patent investigator.

Once upon a time there were two children of poor but honest parents. "I will be a barber when I grow up," said the boy. "It is light, easy work and there are tips for nearly every job." "And I," said his sister, "will be a manicure and then I may marry a prominent club man or a millionaire." But they bethought themselves that public school teachers have three months vacation every summer, and so they became teachers. Thus were an excellent barber and a natural born manicure lost to society, while the educational system of their native city was not at all improved by their presence as instructors.

This fable teaches us that in the Patent Office the requirements for mental equipment are different from those of a barber shop. Comment on desirable compensation is superfluous.

Does American Potash Need a Fixed Price?

AMERICAN potash appears at once to be the child and victim of propaganda. First we had no industry because the Germans assured us that their proven resources of crude salt which could be cheaply mined and shipped in quantity gave them domination over the world. Then when the blockade prevented importation of this desirable substance, the price soared to dizzy heights, and Americans were spurred by an insistent cry, "Give us potash!" to get into the game patriotically and make some money. Apparently there was money to be had, for newspapers far and wide, including those no less respectable and reliable than the Chicago *Tribune*, published "stories" a column long about the fabulous fortunes suddenly acquired by Nebraska potash magnates. No one seemed to take the trouble to deny these wild tales, perhaps because they attracted needed capital to the infant industry and increased our potential supply of salts, or because one recognizes that reasoning beings do not believe such lurid stories should they by chance be read. Here was a grievous sin of omission, however, for the selfsame "potash magnates" are now hard put to explain why they still need the fostering care of governmental price fixing and the limitation of imports to allow them to live and, as they put it, to "reorganize on a peace basis."

There is no question that the production of American potash in quantity is essential for our national well-being. No American wants us again to be dependent solely upon the Germans for any substance required in our domestic economy. If he knows the true story, he will not begrudge the fancy price he had to pay for war-time production. But isn't it about time, after five years of absolute embargo and high returns, that the infant industry show signs of being able to stand on its own feet? If it cannot approach that point under such conditions will it ever be able to walk alone? Will costs in this and other instances have to be indefinitely upheld by the power of a government whose people are demanding relief from high prices with a voice never before so unanimous or insistent?

The truth of the matter is this: That the American potash industry can stand on its own feet, and can now compete with foreign importations, barring dumping, trade war, rebates and such unfair practices; and the sooner the American potash industry comes before the people of the United States with clean hands the better it will be for its good name. Of course there is more money to be had, and that easily, by getting a price fixed for its production, at say $2.50 per unit, than there is in devising ways and means to cut its own costs so they are proof against competition. It's good business, too, the kind of good business that has placed the world over a trembling volcano of industrial unrest. But the other is the good technology which CHEMICAL & METALLURGICAL ENGINEERING will always insist upon: The production of more material for a smaller expenditure of labor and money, an increase in the efficiency of effort and dollars, and the only apparent escape from the present *cul-de-sac* of high wages but higher prices.

Mr. W. E. RICHARDSON, of the Nebraska Potash Producers' Association, and Mr. A. C. HARRAGIN, secretary of the American Trona Corporation, have presented detailed costs of producing potash in 1918 before the House Committee on Ways and Means in support of the so-called licensing bill, which may be restated as follows:

	Nebraska		Trona	
	Per Ton of Crude Salt 20% K_2O	Per Unit K_2O (20 Lb.)	Per Ton of Chloride 50% K_2O	Per Unit K_2O (20 Lb.)
Fuel, labor, repairs, selling and overhead...........	$37.80	$1.89	$32.97	$0.66
Freight on salt to market....	13.00	.65	17.72	.35
Capital charges..........	16.40	.82	61.71	1.24
Royalty.................	17.60	.88	......	....
Total................	$84.80	$4.24	$112.40	$2.25

The less said about the unholy figure for royalty the better. Capital charges appear to be high, especially for the Trona company, where, strangely enough, it is nearly twice as much as the entire operating expense. The bulk of these charges appears to be amortization of investment, designed to be entirely liquidated in two years—evidently unreasonable for going concerns, such as we hope to prove the potash industry to be. Freight is something outside the power of the producer, unless he ships a more concentrated salt. That brings us back to the net operating—$1.89 a unit (9½c. a lb.) in Nebraska and $0.66 a unit (3.3c. a lb.) at Searles Lake.

Nebraska operators evaporate brackish lake water to dryness, and it costs them 9½c. to put each pound of potash in the resulting crude on cars at no profit! The water is there for the pumping. No purification of any sort is necessary. Merely evaporate 60 lb. of water and sack the dirty crystals. Just how careful of outgo the Nebraska men must have been may be judged by a comparison with the beet sugar industry. These men can pay 4c. per lb. to the farmers for the sugar in the beets, collect them by rail, wash, shred and leach the cosettes, evaporate the solution, crystallize and purify the sugar, add in all capital charges and sell refined sugar at wholesale at 9c. a lb. and still get rich at it! Or compare the cost of the Trona company—3.3c. per lb. At Searles Lake the brine is not only evaporated, originally more concentrated, it is true, but in addition a quite delicate separation of large percentage of deleterious salts is necessary before the crystals can be sold.

Using multiple-effect crystallizing evaporators and filters, with reasonably good boiler practice, Nebraska potash can unquestionably be produced f.o.b. factory now at $0.66 per unit, the same as the Trona product, including all charges except capital charges—interest and depreciation. Accepting Mr. SHARP'S statement that four plants with actual output in 1918 of 12,750 tons pure potash cost $2,500,000, capital charges of 34c. per unit would equal 17 per cent for interest and depreciation. Mr. HARRAGIN, by the way, asks for only an ultimate 23c. Consequently with correct technology, the average plant operating on brines—and this source yielded three-quarters of our last year's supply—will not go into bankruptcy if it can get $1 a unit for its potash, f.o.b. plant. Even though the pre-war cost of German potash, f.o.b. American ports, was $0.75 a unit, it is not likely that this price can be approached for some time—in fact future delivery of Alsatian salts has been quoted at $1.70 per unit, even though spot American potash is being sold at $2.25.

Everything considered, it appears certain that the American industry need not fear strangulation from fair foreign competition. In fact, we believe that eventually potash from cement kilns, iron furnaces and sugar mills will command the market and give the brine plants cause for most worry. Who will protect them against this competition, if they do not immediately clean house and reduce their costs, which they admit they can do? In our opinion the potash industry would have the best chance of success if it went before the Tariff Commission, Congress and the President and said: "We can put potash aboard cars as cheaply as the European can put it aboard ships. All we ask is that their advantage in ocean freight rate over our long rail-haul be equalized by a proper protective tariff." This would square them with the only rational tariff policy acceptable to both political parties, disarm suspicion of ulterior motives, eliminate obnoxious licensing and price fixing, and unite all candid members of the industry solidly behind the movement.

A Truce in Labor Demands

THERE is no doubt that President WILSON'S statement made public August 26 will mark the turning point in labor demands. The occasion of the President's utterance was his giving advice that the demands upon the Railroad Administration by the railroad shopmen should not be granted, but he was clear and emphatic in indicating that his observations were of general application. He spoke of "the demands of the shopmen and all other demands." He said, "It is the duty of every citizen of the country to insist upon such a truce" and he appealed to his "fellow citizens of every employment to co-operate in insisting upon the maintaining of such a truce."

The basic idea is that which has been in the minds of most employers and thinking men, that these continued wage advances get us nowhere. The increase in production cost is added, with an increment, to the producer's selling price, and more is tacked on along the line. Then the wage earner experiences more "high cost of living" and makes a fresh demand. The thing to do is to reduce the cost of living and "any substantial increase of wages in leading lines of industry at this time would utterly crush the general campaign the Government is waging, with energy, vigor and substantial hope of success, to reduce the high cost of living."

There can be no doubt that when the President mentioned "leading lines of industry" he had in mind the case of the iron and steel industry. Six days before the President issued his statement the American Federation of Labor's "National Committee for Organizing Iron and Steel Workers" had announced the result of its "strike vote," taken during the 30 days preceding, as 98 per cent affirmative and had appointed a committee of six to seek a conference with the iron and steel producers, the committee having until August 30 to arrange for a conference, failing in which it was authorized to call a strike.

The American Federation of Labor demands were embodied in a platform of twelve planks, given to the press July 20 after the meeting of representatives of 24 unions who decided to take a "strike vote." The strategy was good. The unions represented included those of machinists, bricklayers, molders, plumbers and steam fitters, switchmen, stationary firemen, electrical workers and similar crafts. Many of these unions have strong memberships employed outside the iron and steel industry and the withdrawal of a few of the crafts would greatly cripple mill and furnace operations, even though the strikers comprised but a very small percentage of the total number of men employed. The strategy lay in attempting to produce a strike with a small number of men, the strike being to force complete unionization of the industry. The organizing committee would furnish simply the skeleton and the employers themselves would be required to fill out and make the organization complete.

This was aimed at by nothing less than the odious "check-off" which was No. 9 of the twelve demands, No. 1 being "collective bargaining." These two points, however, would merely establish the union. To make a union function as union men want unions to function the man must be made a non-entity, with no personality, no particular degree of skill, nothing to distinguish him from other men. To destroy individuality, to kill efficiency and to complete the surrender of the plants to the men, the following requirements were incorporated in the demands: No. 7, "Standard scales of wages for all crafts and classifications of workers," and No. 10, "Principle of seniority to apply in maintaining, reducing and increasing working forces." Lest it be thought that these two demands would represent so utter a surrender that nothing further could be asked, it must be mentioned that there were two more along this line, No. 2 calling for "Reinstatement of all men discharged for union activities with pay for time lost," when of course the claim would be made that all union men discharged had been discharged on that account, and No. 12, "Abolition of physical examination of applicants for employment." That is a confession that the organizers consider it profitable under the liability laws for a workman to be injured, even though it was not the injured who was physically unfit, but his fellow workman.

It is significant that in the platform as a whole demands representing directly or indirectly wage advances or decreases in the hours of labor were distinctly subsidiary, though of course such demands would be insisted upon. Granting the demands would involve not only the increase in production cost directly arising from higher wage rates and shorter hours but also a great increase due to lessened efficiency, and it is well indeed that the American Federation of Labor program has been dealt a stunning blow by the pronouncement of the President that there must be a truce in these things.

Western Chemical and Metallurgical Field

Colorado Potash Company

THE following brief description of the Colorado Potash Co.'s activities has been given to us by Dr. J. Gillingham Hibbs of Denver, Colo. The company was organized and operated by Fuller-MacCulloch Co., a partnership consisting of Messrs. Edmund Fuller and Thomas MacCulloch, both of Denver, who have been developing a process for the production of potash by the electrolytic decomposition of feldspar and leucite under a patent recently issued.[1]

Feldspar is found within 20 miles of Denver in ample quantity for any production hoped for in that region, and is mined by benching in the open. This matter of proximity of supply yields a low cost of raw stock. The rock is crushed to about 60 mesh, decomposed in digesting pans and electrolyzed in special earthenware cells to potassium aluminate, with an accompanying complete segregation of the silicon content of the rock.

The crux of the process is the diaphragm cell. This special porous pot contains the cathode, immersed originally in pure water contained within the diaphragm. Surrounding this and inclosed in the cell body itself is the sulphuric acid solution of decomposed feldspar, in which the anode is immersed. Impressed current now ionizes the solution, and the alkali and aluminum travel through the diaphragm, forming $KAlO_2$ at the cathode, while amorphous silicon remains as a sludge about the anode. By insertion of proper tanks and pumps the electrolysis can be made continuous, fresh solution replacing the silica-bearing sludge, and water the alkaline aluminate.

The $KAlO_2$ is broken down by action of CO_2, resulting in aluminum hydrate and K_2CO_3; the latter remaining in solution while the $Al(OH)_3$ is precipitated. The K_2CO_3 solution is decanted, the remaining aluminum hydrate washed and dried by an atomizing process. The potash solution is now in a condition for the production of any desired commercial salt. This liquor contains practically 100 per cent potassium or sodium carbonates, the potash content being in the same ratio as in the original feldspar. With the material used the potassium salts will be greater than 90 or the sodium salt less than 10 per cent. There is no magnesium in it, wherein it differs from the Nebraska and Salt Lake brines. It is also free from chlorides, which is a feature of leading importance in tobacco fertilization.

At present the firm is addressing itself to the production of 100 per cent soluble K_2SO_4, which is accomplished by digestion with gypsum, whereby a pure calcium carbonate is precipitated. The solution is decanted, or after washing the precipitate the solution is also dried by an atomizing process.

Work is now under way to perfect various mechanical features of the process, particularly washing and handling the flocculent alumina precipitate. This, being free from iron and other deleterious impurities, should be available for the production of metallic aluminum. Large quantities of amorphous silica, containing some aluminum compounds, are also separated from the circulating electrolyte, and this material will probably be welcomed by the ceramic industry. When the problems in chemical engineering connected with the production of potash salts have been solved in the present small-scale unit, the company intends to install duplicate cells and equipment in its roomy plant sufficient to produce 300 tons K_2SO_4 per month, with its accompanying 165 tons Al_2O_3 and 700 tons silica. Eventually, the company plans erecting numerous plants near agricultural centers, where sufficient supplies of potash-feldspars, gypsum and phosphate may be obtained, and market a 100 per cent soluble material comprising a balanced proportion of potash, phosphate and nitrate.

Preliminary experimentation has convinced Dr. Hibbs and his associates that they can eventually supply the Middle West with its fertilizer requirements in potash and potash in combination with nitrogen and phosphorus at less than pre-war costs, provided, always, the farmer can be educated to the use of concentrated plant foods. A model garden of 14 acres is in preparation to demonstrate the advantages in the use of pure salts over fertilizers having a large filler content.

The Vanadium Situation

The demand for alloy steels containing vanadium is large and there will undoubtedly be an increasing demand for these alloys. The automotive industry is active, particularly in the production of trucks and tractors, and this industry is the largest consumer of these steels at present. However, the stock on hand seems to be sufficient for requirements and the market is quiet. Ferrovanadium, 30 to 40 per cent, is quoted at \$5.50 to \$7 per pound of contained vanadium.

About three-fifths of the vanadium consumed in this country is obtained from Peru. The remainder is produced from deposits in the Western States and of this about nine-tenths is mined at Vanadium, Colo. Scattered mines, principally in Arizona and New Mexico, supply the remainder, excepting a small amount which is produced as a by-product from radium ores. The American Vanadium Co. produces ferrovanadium from the South American ores and the Primos Chemical Co. from domestic ores, these two companies being the largest in the field. The mill of the Primos Chemical Co., which was destroyed by fire, has been rebuilt and started operating at full capacity Aug. 1.

The trend of ferrovanadium prices will probably be determined by the cost of production from the domestic ores. It is also probable that this trend will be upward due to high wages, increasing depth of mining operations and a decreasing quality of ores obtained. This upward tendency should be checked by the production from as yet undeveloped sources and by the substitution of other alloy steels, particularly molybdenum.

Cuprodescloizite and vanadinite are possible sources of supply. Metallurgical methods for the treatment of these ores have been published.* A zincdescloizite has been discovered in Nevada; the quantity of this mineral available has not been determined as yet nor has a method been worked out for its metallurgical treatment. A large deposit, for a vanadium ore, occurs in the Shattuck-Arizona mine at Bisbee.

---

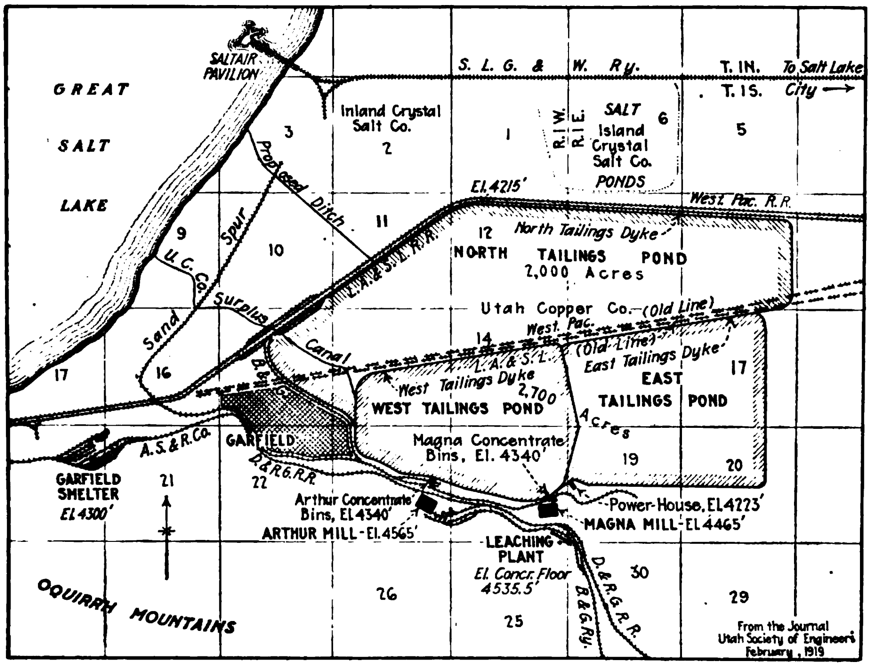
[1] Potash Extraction, 1,253,560, Jan. 15, 1919.

*"Treatment of Cuprodescloizite for the Extraction and Recovery of Vanadium, Lead and Copper"; J. E. Conley, CHEM. & MET. ENG., vol. 20, p. 465.

"A Proposed Metallurgical Process for the Treatment of Vanadinite for the Recovery of Lead and Vanadium"; J. E. Conley CHEM. & MET. ENG., vol. 20, p. 514.

Utah Copper Tailings Pond

With the growth of mining acreage and the scale of milling operations, the Utah Copper Co. encountered the problem of properly disposing of the tremendous amounts of tailings produced daily at its two mills. Thus, the early estimates of ore reserves at the mine in Bingham Canyon were 37,500,000 tons and, in 1907, the mill was expected to handle perhaps 5000 tons of ore daily. By purchase of the Boston Consolidated and other properties in the canyon, the existing ore reserves have now been increased ten times, to 374,000,000 tons, despite mining in the meantime more ore than twice the original estimate. Milling during 1918 proceeded at the rate 33,317 tons daily, and the rated capacity of concentrators and leaching plant is no less than 43,000 tons. As Mr. H. C. Goodridge, their chief engineer, pointed out at a recent meeting of the Utah Society of Engineers, a tenfold increase in available ore and a ninefold increase in milling capacity has rendered insufficient the originally ample tailings area.


SALTAIR PAVILION
GREAT SALT LAKE
S. L. G. & W. Ry.
T. 1N.
T. 1S.
To Salt Lake City →
Inland Crystal Salt Co.
R. 1 W.
R. 1 E.
SALT Island Crystal Salt Co. PONDS
Proposed Ditch
Spur
U. C. Co. Surplus
Sand
Canal
B. & G.
El. 4215'
West Pac. R.R.
L. A. & S. L. R.R.
North Tailings Dyke
NORTH TAILINGS POND
2,000 Acres
Utah Copper Co.
(Old Line)
West. Pac.
(Old Line)
L. A. & S. L.
East Tailings Dyke
EAST TAILINGS POND
West Tailings Dyke
WEST TAILINGS POND
2,700 Acres
Magna Concentrate Bins, El. 4340'
A. S. & R. Co.
GARFIELD
D. & R. G. R.R.
GARFIELD SMELTER El. 4300'
Arthur Concentrate Bins, El. 4340'
ARTHUR MILL - El. 4565'
Power-House, El. 4223'
MAGNA MILL - El. 4465'
LEACHING PLANT El. Concr. Floor 4535.5'
D. & R. G. R.R.
B. & G. Ry.
OQUIRRH MOUNTAINS
1
2
3
5
6
9
10
11
12
14
16
17
17
19
20
21
22
25
26
29
30
From the Journal Utah Society of Engineers February, 1919

A map shown herewith gives a general idea of the location of the mills and smelter near the Great Salt Lake shore. The southwestern portion of this mapped area is rough, the Bingham & Garfield and Denver & Rio Grande railways skirting the Oquirrh Mountains, which rise directly out of the flatlands surrounding Salt Lake. Thus the mills are constructed on a hillside about 125 ft. above the general ground level to the north. Across this marshy flat some mile and a half away were situated the main lines of two transcontinental railways, and the intervening area has been used for tailings since the commencement of operations.

Various schemes for enlargement were studied by the mining company's engineers. Should all the expected ore be impounded in the so-called West and East Tailings ponds, it would require dikes around the area to an average height of 80 ft. and an eventual slope on top of the pond of but 0.5 per cent. The total estimated cost of this scheme was $1,680,000. Another plan was based on making two independent ponds with dikes paralleling the two transcontinental railroads on the north and south, with a maximum height of 92 ft., at an estimated cost of $3,885,000. Such a mass of loose material in close proximity to the railroads would be a continual menace to their operation, and these schemes were abandoned.

It then appeared necessary to move the railroads. If they were shifted about a half-mile north and connected with the old lines at the old Garfield station, a dike about 30 ft. high would be needed to impound all tailings resting at a grade of 0.9 per cent. The cost of this scheme was about $2,265,000. However, by moving the tracks still farther north, and rebuilding the Garfield station, a tailings area of 6000 acres could be provided, sufficient for all material, at an average slope of about 0.92 per cent without its toe encroaching on the railroads; in other words, without the necessity of diking, except, perhaps, to impound and clarify water before drainage into the lake. This plan, which was adopted, cost about $910,000, chiefly for new lands and railroad revision. The latter item was by agreement done without cost to the railroads, a new roadbed being provided equal to the old, $2000 per mile allowed for extra surfacing work until the roadbed settled, and an amount capitalized at $46,000 for additional expense of operation due to added distance and curvature.

The North Tailings Pond, which was originally from 6 to 12 in. under water, was first drained by digging the ditches eventually needed for tailings water, and the embankments made by drag-line excavator at a cost of 25c. per yard.

The 12-ft. dike is 7 miles long, furnished to a top width of 10 ft. for a railway track to handle riprapping, which latter is smelter slag placed for about 80c. per cubic yard.

Statistics on Turpentine and Rosin

As an aid to the development of the naval stores industry, statistics regarding production and supply of turpentine and rosin are being collected by the United States Department of Agriculture through specialists in the Bureau of Chemistry.

Blanks on which to report have been sent to all producers and users in the United States whose names and addresses are available. This information will show the amount on hand April 1, 1919, the quantity made this season up to Aug. 1, the amount actually on hand at the stills Aug. 1, and the estimated production for the balance of the season. It is expected that the data will be published by Sept. 1.

Similar statistics regarding last season's production and available supply of rosin and turpentine proved to be of much interest to producers and consumers alike. Information regarding last season's output, or blanks for reporting this season's supply, may be obtained upon application to the United States Department of Agriculture, Washington, D. C.

War-Time Activities of Dye Plants in Germany

THE report of the British mission appointed to visit enemy chemical factories in the occupied zone was introduced at the dyestuffs hearings before the House Committee on Ways and Means, in order to emphasize the military value of a well-developed chemical industry. The following data have been taken from this report. In some cases ~~difficulty~~ was experienced in obtaining accurate details of manufacture, especially as regards substances which have a peace value, and the information must be accepted with some reserve on this account, although it was checked by cross-examination of the officials concerned and by a careful examination of the plant admittedly employed for war purposes.

Some years before the war a combination was formed by the Bayer, Badische and A. G. F. A. companies and somewhat later a second group was formed which included Meister, Lucius & Bruning, Casella & Kalle. During the war these two groups amalgamated, and the Griesheim Elektron, Weiler-ter-Meer, Leonhardt and other smaller companies entered the combination, which is known as the I. G. (Interessengemeinschaft). It was largely owing to the efforts of this combination that Germany was enabled to continue the war in spite of the blockade. The I. G. works produced the bulk of the synthetic ammonia and nitric acid needed for the production of fertilizers and explosives, all the poison gas (with the exception of some chlorine and phosgene), and a large proportion of the high explosives.

The following are the more important works of the I. G. which were not visited, as they are outside the occupied zone:

Factories of the Aktien Gesellschaft für Anilinfabrikation.
Factories of the Griesheim Elektron Gesellschaft.
Factory of the Bayer Co. at Elberfeld.
Factory of the Badische Co. at Merseburg.
Factory of Casella & Co., Mainkur, near Frankfurt.
Factory of Leonhardt & Co., Mulheim, near Frankfurt.

A summary of the information obtained as to the war production of the factories visited is given under the headings of "Initial Products," "Explosives and Poison Gases."

INITIAL PRODUCTS FOR MANUFACTURE OF EXPLOSIVES AND POISON GAS.

The principal materials concerned are ammonia, nitric acid, sulphuric acid and chlorine, and it was on the output of these that the war production of chemical munitions depended. The expansion of output by the factories of the I. G. combination during the war is shown by Tables I-IV.

Explosives. No arrangements appear to have been made prior to the outbreak of war to utilize the resources of any of the dye factories for war purposes, and on mobilization their chemists were called up for military service. After the battle of the Marne the government realized the need for expanding the output of explosives and most of the chemical works were producing small quantities by the end of 1914. The demands made on them increased during 1915, but it was not until 1916 that plant was laid down to assist in the enormous production of explosives required by the Hindenburg program. Most of the big extensions of the synthetic ammonia and of the nitric and sulphuric acid plants date from this time, many chemists being released from the army and the scientific staff of some of the works being augmented. Standardized plant used for the manufacture of dyes was converted for the production of explosives with remarkable speed; for instance, at Leverkusen a TNT plant producing 250 tons per month was put into operation in six weeks.

TABLE I.—AMMONIA (METRIC TONS NH_3 PER DAY)

	1914	1918
Oppau	25	250
Merseburg	Nil	400
Total	25	650

TABLE II.—NITRIC ACID (METRIC TONS 100 PER CENT ACID PER DAY)

	1914	1918
Leverkusen	56	180
Hochst	150	375
Oppau*	?	100
Ludwigshafen	(?) 40	40
Weiler-ter-Meer	12	24
Total	258	719

*Oppau has the power to produce now 500 tons HNO_3 daily, still retaining sufficient ammonia to supply the output at Hochst.

TABLE III—SULPHURIC ACID (METRIC TONS 100 PER CENT ACID PER DAY)

	1914	1918
Leverkusen	340	470
Hochst	224	280
Ludwigshafen	275	410
Weiler-ter-Meer	48	60
Total	887	1,220

Meister, Lucius & Bruning have also erected a large new plant at Hochst which has not yet started and was not examined.

The Bayer Co. has erected at Dormagen a large vitriol plant equal to 250 tons per day.

TABLE IV—CHLORINE (METRIC TONS PER DAY)

	1914	1918
Leverkusen	7	20
Hochst	4	8
Ludwigshafen	13	35
Total	37	63

Tables V and VI show the amounts produced in the factories visited.

TABLE V—HIGH EXPLOSIVES AND INTERMEDIATES

Quantities of intermediates are shown only where these were not converted to finished explosives in the producing works.

(Metric tons per week)

Factory	Ammonium Nitrate	Dinitrobenzene	Dinitrotoluene	Trinitrotoluene	Mononitro-naphthalene	Dinitronaphthalene	Dinitrochlorbenzene	Dinitrophenol	Picric Acid	Trinitroanisole	Dinitrodiphenylamine	Hexanitrodiphenylamine
Leverkusen	...	250	...	250	...	150	40	..	...	[1] 3	....	....
Domagen	...	...	...	...	...	...	...	..	600	..	....	....
Urdingen	...	60	...	75	([2])	...	...	..	...	..	....	....
Hochst	500	140	...	200	...	...	...	..	...	30	....	[1] 1½
Ludwigshafen	...	25	50	...	...	15	300	35	...	..	[3] 25	....
Oppau	200	...	...	...	...	...	...	..	...	..	....	....
Merseburg	(?)	...	...	...	...	...	...	..	...	..	....	....
Wiesdorf	...	...	120	...	...	...	...	..	...	..	....	....
Schlebusch	100	...	...	150	...	...	...	..	...	..	....	....

[1] For 3 months only. [2] Small. [3] For 1 year.

Other intermediates—Ludwigshafen, sodium benzene sulphonate, 100 tons per week.

Other explosives—Schlebusch, hexanitrodiphenylsulphide, 15 tons per week.

TABLE VI—PROPELLANT EXPLOSIVES, DETONATING SUBSTANCES, ETC.

(Metric tons per week)

Factory	Nitrocellulose Powder	Diethyl diphenylurea	Diphenylamine	Nitroglycerine	Cordite Paste	Tetryl.	Fulminate	Lead Azide
Urdingen	...	35	7	....	..	..	..	...
Kuppersteg	...	..	..	....	..	..	..	0.7
Troisdorf	250	..	..	21	40	6	7	0.7
Schlebusch	...	..	..	....	..	..	..	...
Opladen	...	..	..	35	75	..	..	...
Wiesdorf	...	..	..	(?) 50	40	..	..	...

Poison gas. At first chlorine and phosgene were the main requirements, but afterward a variety of organic substances were employed, all of which were made by the factories of the I. G. combination. Many of these substances were new and difficult to prepare, and rapid production was only possible owing to the speed with which the peace organization of the dye factories could be utilized for this purpose. When the government wished to introduce a new gas, a conference of the various firms was held at Berlin to determine how the manufacture should be subdivided in order to use existing plants to the best advantage. For instance, the initial stages of the manufacture of mustard gas were carried out at Ludwigshafen and the final stage at Leverkusen.

Tables VII and VIII show the production of gas and intermediate products in the various factories visited.

TABLE VII—OUTPUT OF FINISHED POISON GASES FROM VARIOUS WORKS

	Factory	Monthly Output (Metric Tons) Average	Monthly Output (Metric Tons) Maximum	Total Production (if known) Tons	Date of Commencement
1. Chlorine	Leverkusen	600	.....	......	Prior to war
	Hochst	240	.....	......	Prior to war
	Ludwigshafen	860	1,261	38,600	Prior to war
2. Phosgene	Leverkusen	...	30	......	Prior to war
	Ludwigshafen	288	621	10,682	Prior to war
3. Diphosgene	Leverkusen	...	300	......	June, 1915
	Hochst	139	266	3,616	Sept., 1916
4. Chlorpicrin	Leverkusen	...	200	......	July, 1916
	Hochst	45	101	1,127	Aug., 1916
5. Xylyl bromide	Leverkusen	...	60	......	Mar., 1915
6. Bromacetone	Leverkusen	...	20	......	July, 1916
7. Bromacetone, bromethylmethylketone	Hochst	19	45	685	Apr., 1915
8. Phenylcarbylamine chloride	Hochst	65	124	721	Mar., 1917
9. Mustard gas	Leverkusen	...	300	[1] 4,500	Before July, 1917
10. Diphenylchlorarsine	Hochst	150	300	3,000	May, 1917
Diphenylcyanoarsine	Hochst	...	.....	......	Feb., 1918
11. Ethyldichlorarsine	Hochst	78	150	1,092	Aug., 1917
12. Dichlormethyl	Hochst	26	51	233	Sept., 1917
13. Dibrommethylether	Hochst	7	29	69	Apr., 1917

[1] Estimated from capacity of plant. Probably the same quantity was produced at some other factory, as the output of thiodiglycol from Ludwigshafen would suffice for this.

TABLE VIII—OUTPUT OF INTERMEDIATE PRODUCTS FOR POISON GAS MANUFACTURE

Finished Gas	Intermediate Products	Total Output (Metric Tons)	Place of Production	Destination of Intermediate Products
Phenylcarbylamine	Phenyl mustard oil	([1])	Kalle	Hochst
Mustard gas	Thiodiglycol	7,026	Ludwigshafen	Leverkusen and 1 other factory
Diphenylchlorarsine	Phenylarsenic acid	1,600	Ludwigshafen	Unknown
		1,200	Kalle	Unknown
	Diphenylarsenic acid	4,800	Leverkusen	Probably A. G. · F. A., Berlin
Ethyldichlorarsine	Ethyl arsenious oxide	840	Ludwigshafen	Hochst

[1] Not obtained.

Note.—In addition Hochst produced 3,000 tons of diphenyl chlor- and cyanarsines from own intermediates.

MILITARY IMPORTANCE OF THE GERMAN CHEMICAL INDUSTRY

These figures for the output of explosives and gas show the great military value of the factories of the I. G. combination. Although no arrangement had been made to mobilize them at the outbreak of hostilities, they were rapidly converted to war purposes, thanks to their highly trained personnel and the great technical resources of their peace organization. In the future it is clear that every chemical factory must be regarded as a potential arsenal, and other nations cannot therefore submit to the domination of certain sections of chemical industry which Germany exercised before the war. For military security it is essential that each country should have its chemical industry firmly established, and this must be secured as one of the conditions of peace, as otherwise we are leaving Germany in possession of a weapon which will be a permanent menace to the peace of the world.

The key to Germany's war production of explosives was the Haber process for the production of ammonia from atmospheric nitrogen. It is significant that large-scale production by this process only began at the end of 1912, and that in the early part of 1914 great pressure was put on the Badische Co. to increase its output. During the war, owing to the extension of the Haber plants at Oppau and Merseburg, Germany has become independent of foreign countries for her supplies of ammonia and nitric acid, substances indispensable for the manufacture not only of high explosives but also of fertilizers for food production. Without such a process Germany could not have made the nitric acid required for her explosives program, nor obtained fertilizers for food production after the supply of Chile saltpeter had been stopped by the blockade, and it is probable that she could not have continued the war after 1916. In the event of another war we might be cut off from supplies of saltpeter.

The resources of the German dye industry are of no less military importance. Most of the gases employed toward the end of the war were complex organic substances, none of which had been made previously except in small quantities, and some of which were prepared for the first time during the war. Gas warfare will undoubtedly continue to develop in this direction, and in the future organic substances will be employed which we do not know today. The use of gas will always offer great opportunities for surprise in military operations, and the experiences of the present war have shown that rapid production of a new gas is essential if the surprise is to be effective. Any country without a well-developed organic chemical industry will be severely handicapped in this respect.

Re-employment Problems and Methods

ALTHOUGH the Victory Loan supplied the funds necessary to bring the boys from France, many of the returned soldiers, sailors and marines have experienced great difficulty in finding their places once more in the business world. This is especially true of young men who left college to enter the service and who now find it impossible to finish their courses, for financial or other reasons. In seeking employment, they find that the other men who have completed college courses have the preference and command the higher salaries, and yet in order to insure decent living conditions for themselves and their families, they feel that they must ask as much as the other men. They do not always get it, and for this reason an appeal is made to the employer of college-trained men to give men of this type a chance to make up in the plant or in the office the time lost while in service—to pay them a living wage during this period and to consider any resulting additional expense as an investment in the nature of a final Liberty Loan. These men made good Over There, and all that they ask now is the opportunity to show that they can do the same over here!

According to Mr. F. A. Giffin, in charge of the Placement Division for Executive, Professional and Technical Men of the Re-employment Bureau of New York City, the problem of the inexperienced college man, as outlined above, is the greatest one with which the Technical Division has had to contend and yet one which may be easily solved, if employers will again show the spirit which made the Liberty Loans so successful.

The Re-employment Bureau of New York City was organized in April, 1919, to centralize all employment work for ex-service men in New York City. It has developed into a wonderfully efficient organization for bringing together the man and the job. The work is under the jurisdiction of the Re-employment Committee, of which William Fellowes Morgan, president of the Merchants Association, is chairman, and two advisory councils: the United Council of Re-employment, composed of representatives of seventeen welfare organizations and employment services, and the Employers' Council, composed of representatives of eighty-two commercial and trade organizations in Greater New York. The Bureau, which is under the immediate direction of Major Warren Bigelow, is divided into the following departments:

The Procurement Division has charge of obtaining sufficient jobs and of caring for unsolicited jobs which come in either by mail or by telephone.

The Registration Division has charge of registering the applicants and obtaining the information necessary for the Placement Division, and also classifying and routing the applicants to the proper placement sections, as well as filing cards and records of applicants and those who have obtained positions through the Bureau. The Registration Division has registered about 27,000 men.

The Vocational Division, which is a unique feature of the Bureau, endeavors to guide unskilled workers into trades which are not overcrowded and which will offer them a future.

The Placement Division consists of three main sections: General Placement, with eleven classified subdivisions such as, general labor, skilled mechanics, disabled men, salesmen, office clerks, etc.; Recruiting for Army, Navy, Marines, Air Service, Motor Transport Corps and the Shipping Board; Placement for Executive, Professional and Technical Men.

The last mentioned section takes care of all mental workers who receive $1500 a year or over. About 12 per cent of the total registrants are referred to this division, i.e., about 200 per week. Of these, approximately 20 per cent are placed, 50 per cent find positions themselves or through some other agency or go back to their old jobs, while the remaining 30 per cent accumulate. (About 40 per cent of this class, which numbers over 700 at the present time, belong to the group of young college men referred to earlier in this article.) This division has placed over 500 men with an average salary of $35 per week at a cost of $9-$10 per placement. The men registered range from privates to lieutenant-colonels and some have been placed in positions paying as high as $25,000 a year. It is estimated that 95 per cent of the men placed stick to their new positions.

There is a great demand for skilled technical men, especially senior mechanical and electrical engineers, since the supply of graduate engineers has been shut off by the war. However, there is an oversupply of junior engineers and there is practically no demand for civil engineers, so that many of the latter are giving up their profession and entering a business career. Increased activity in proposed construction work was first shown by the extraordinary demand for architectural draftsmen and later for structural draftsmen, concrete and steel designers.

Another problem is the placement of professional men, particularly lawyers and physicians, who have lost their practice while in service or who desire to change to some other line of work. Many physicians have expressed themselves as unwilling to return to the practice of medicine.

A summary of the work done by the Bureau as a whole from the date of organization until Aug. 25 shows that 27,000 men have been registered, 15,200 have been placed at an average cost of about $5 per placement and that 66,000 positions have been registered by the Procurement Division.

Although the Army will be practically completely demobilized by the end of September, the Bureau has learned from experience that it takes from four to five weeks for the ex-service man to reach the Bureau after discharge and from two to three weeks more to place him, so that the work of the Bureau will in all probability continue until the first of November.

Philadelphia Meeting of the American Chemical Society

The fall meeting of the American Chemical Society will be held at the Bellevue-Stratford Hotel, Philadelphia, Pa., under the auspices of the Philadelphia Section, from Tuesday, Sept. 2, to Saturday, Sept. 6, inclusive. The Philadelphia Section, situated as it is so near the center of our chemical activities, is planning an extensive and unusual program.

The Rubber Division holds its first meeting and a Dye Section is to be established which will function as a separate section this year. The Industrial Division—organized in New Haven in 1908 for chemists in industrial research laboratories, for consulting chemists and chemical engineers and for business executives who find it profitable to keep in touch with the developments in applied chemistry—will hold a symposium on refractories organized by Dr. A. V. Bleininger of the Bureau of Standards. A discussion will also be held upon Dr. B. C. Hesse's open letter concerning annual patent renewal fees for the United States.

The Chemical Warfare Service and the chemical fraternity Alphi Chi Sigma have planned reunions in conjunction with the meeting.

Among the many interesting papers to be read at the general and divisional meetings the following may be mentioned:

General Meeting.—"Stream Pollution and Its Relation to the Chemical Industries," Earle B. Phelps; "The Building of Atoms and the Periodic Systems," W. D. Harkins.

Rubber Division—"The Action of Certain Organic Accelerators in the Vulcanization of Rubber," G. D. Kratz, A. H. Flower and Cole Coolidge; "Reactions of Accelerators During Vulcanization," C. W. Bedford and Winfield Scott; "The Effect of Organic Acceleration on the Vulcanization Coefficient," D. F. Cranor; "The Effect of Compounding Ingredients on the Physical Properties of Rubber," C. Olin North; "The Manufacture and Use of Crimson Antimony," J. M. Bierer; "Research on Zinc Products for the Rubber Industry," P. R. Croll and I. R. Ruby.

Division of Physical and Inorganic Chemistry.—"A Slide Rule for Special Cases," F. C. Blake; "The Catalyst in the Oxidation of Ammonia," G. A. Perley; "A Metal to Glass Joint and Some of Its Applications," E. C. McKelvy and C. S. Taylor.

Division of Industrial Chemists and Chemical Engineers. —Report on the Production of Synthetic Organic Chemicals in the Research Laboratory of Eastman Kodak Co., 1918 and 1919, C. E. K. Mees; Symposium on Refractories, A. V. Bleininger, Chairman: "The Classification of Refractories," G. H. Brown; "Work of the Technical Department of the Refractories Manufacturers' Association," R. M. Howe; Symposium on Annual Patent Renewal Fees with the Division of Pharmaceutical Chemistry and Section of Dye Industry, E. J. Prindle, Chairman: "Carbon Black—Its Properties and Uses," lantern, G. St. J. Perrott; "Adherent Rust as an Accelerator in the Corrosion of Iron and Steel," lantern, W. D. Richardson; "Some Properties of Commercial Silicate of Soda," J. G. Vail; "The Leaching of Zinc Chloride from Treated Wood," Ernest Bateman; "Tensile Strength of Glue," G. Hopp; "A New Illuminator for Microscopes," third paper, A. Silverman; "The Extraction of Potash Salts From Kelp Charcoal," by title, J. W. Turrentine and P. S. Shoaff; "Kelpchar, a New Decolorizing Carbon Prepared as a By-Product in the Extraction of Potash From Kelp," by title, J. W. Turrentine, P. S. Shoaff and G. C. Spencer.

Fertilizer Division.—"The Conservation of Nitrate of Soda in the Chamber Process for the Manufacture of Sulphuric Acid," Andrew M. Fairlie; "The Caking of Sulphate of Ammonia," C. G. Atwater and J. F. W. Schnultz; "The American Potash Industry," R. O. E. Davis.

"American Storax" From the Red-Gum Tree

A gum which is in demand by the manufacturers of perfumes, tobacco, adhesives and pharmaceutical preparations is produced by the red-gum tree (Liquidamber styraciflua) of the South, though few owners of this tree apparently are yet aware that the gum has any commercial value. The properties and composition of this "sweet gum," as it is called, are similar to those of Oriental storax, obtained from a tree (Liquidamber orientalis) which grows in Asia Minor. Cinnamic acid and cinnamic alcohol are two of its valuable components.

Because the war curtailed the supply of the imported product, the U. S. Forest Products Laboratory this season undertook some co-operative experiments to develop methods of gathering "sweet gum" or "American storax." Although the yield of gum from each tree is not large, a price of $2 or more a pound has made its collection attractive to many individual operators, and a considerable quantity has been put on the market.

The laboratory experiments will be completed in November, and it is hoped that they will provide some cost data which will indicate to what extent "American storax" can profitably compete with the foreign product when normal conditions return.

United Engineering Society Resolutions Relating to Andrew Carnegie

Andrew Carnegie's death Aug. 11, 1919, at Shadow Brook, Lenox, Mass., brought to its close a career which greatly advanced all the engineering arts and sciences. By the introduction into the United States of the bessemer process for the production of steel and by the establishment and development of steel plants which became the greatest in the world, he made available for engineers the most useful modern material for engineering construction. In the successful conduct of many industrial enterprises he amassed great wealth, the possession of which he became to regard with deep seriousness as a public trusteeship. He devoted himself to the distribution of large portions of his fortune to projects for the benefit of mankind. He distributed his wealth not only in many directions, but also with the exercise of great wisdom based on careful investigation. His munificence provided large funds for the building of a home for the great national engineering societies and many associate societies. He was an honorary member of the American Institute of Mining and Metallurgical Engineers and of the American Society of Mechanical Engineers. He was personally known and loved by many engineers. In view of these facts,

Resolved, That the American Societies of Civil, Mining, Metallurgical, Mechanical and Electrical Engineers, the United Engineering Society and the Engineers Club herein express to the family of Mr. Carnegie and record their sincere appreciation of the great contributions of Andrew Carnegie to the advancement of engineering, and of his friendly assistance in making possible beautiful homes for the Engineering Societies and the Engineers Club, thus fostering the spirit of unity in the profession.

Exports and Imports

The Bureau of Foreign and Domestic Commerce of the Department of Commerce reports for June, 1919:

DOMESTIC EXPORTS FROM THE U. S. BY COUNTRIES

	Caustic Soda		Soda Ash	
Countries	Lb.	Value	Lb.	Value
Greece	78,400	$2,157		
Italy	1,747,162	140,376		
Netherlands	25	7		
Norway	454,984	16,778	18,800	$500
Roumania	22,400	728		
Russia in Europe	112,050	3,082		
Spain	226,175	12,216		
Sweden	199,220	7,393	285,788	9,979
England	89,600	2,450		
Canada	829,444	26,814	4,539,974	106,416
Costa Rica	10,264	289	3,000	98
Guatemala	6,635	323		
Honduras	21,150	869		
Nicaragua	2,075	70	2,409	68
Panama	28,715	685		
Salvador	7,800	250	1,500	50
Mexico	558,042	17,926	68,146	2,358
Newfoundland and Labrador	9,000	259	1,452	33
Trinidad and Tobago	3,850	540		
Other British West Indies	50	2		
Cuba	200,850	6,409	150,200	2,970
Danish West Indies	125	9		
French West Indies	112	4		
Dominican Republic	2,400	92	300	8
Argentina	671,396	22,722		
Bolivia	9,000	319	2,500	50
Brazil	605,963	18,365	1,800	54
Chile	110	55	22,500	1,170
Colombia	22,059	836	900	25
Ecuador	4,050	117		
Peru	77,116	2,468	54,000	1,175
Uruguay	90,100	4,335		
Venezuela	24,171	1,082	300	15
China	352,680	11,397		
British India	156,850	4,452		
Straits Settlements	8,000	240		
Dutch East Indies	260,530	9,238	81,198	2,628
Hongkong	248,125	9,686		
Japan	5,676,374	182,606	680,703	10,221
Siam	1,450	150		
Turkey in Asia	1,950	68		
Australia	45,200	2,981		
New Zealand	10,598	750		
French Oceania	4,006	184		
Philippine Islands	905,854	38,840	1,000	31
British South Africa	23,600	1,200		
Egypt	196,000	6,125		
Total	14,005,710	$557,944	5,916,470	$137,849

DOMESTIC EXPORTS OF GLYCERINE FROM THE U. S. BY COUNTRIES—IMPORTS INTO THE U. S. BY TOTALS

Exports

Countries	Lb.	Value
Greece	2,874	$819
Portugal	800	176
Russia in Europe	50	11
Spain	1,846	603
Turkey in Europe	2,000	640
British Honduras	18	5
Canada	27,448	6,942
Costa Rica	74	21
Guatemala	125	30
Honduras	115	34
Nicaragua	50	11
Panama	1,090	155
Salvador	80	24
Mexico	3,780	959
Trinidad and Tobago	300	54
Other British West Indies	35	8
Cuba	999	228
Danish West Indies	50	12
Dominican Republic	822	188
Argentina	87,570	21,095
Bolivia	50	12
Brazil	645	151
Chile	7,684	1,558
Colombia	1,092	276
Ecuador	174	36
Dutch Guiana	100	27
Paraguay	101	28
Peru	2,679	648
Uruguay	7,020	1,360
Venezuela	520	134
China	17,227	4,280
British India	8,764	1,935
Straits Settlements	500	168
Hongkong	969	310
Japan	240,591	34,195
Siam	336	57
Turkey in Asia	5,000	1,050
German Oceania	10	3
Philippine Islands	6,203	1,099
Total	429,791	$79,342

Imports

	Lb.	Value
Total	318,030	$42,505

The Export Trade Act

THE numerous requests for copies of the export trade act (Webb-Pomerene law) and the large number of inquiries about it call for the publication of a separate pamphlet[1] by the Federal Trade Commission for the information of those desiring to co-operate in the development of our foreign trade through association formed under that act.

We present herewith the outstanding features of this pamphlet.

A complete reprint of the Webb-Pomerene law (Public 126, 65th Congress) is given, together with such sections of the Sherman act, the Clayton act and the Federal Trade Commission act as are referred to in the Webb act. Five pages are devoted to a discussion of the act, including a summary of the law, a discussion of requests for rulings and a list of all organizations that have filed papers purporting to be under section 5 of the Export Trade act. One of the difficulties which exporting houses seem to find with the law is that export companies usually do both an export and import business, while the law provides that its protection is given to associations entered into for the sole purpose of engaging in export trade and actually engaged solely in such export trade.

PRACTICE AND PROCEDURE

In several instances suggestions have been made as to modification of proposed articles of incorporation, already filed, in order that these associations may clearly come within the provisions of the act. The commission is authorized by this law to make recommendations as to how export associations may conform their business to the law, and, within its powers, it proposes to advance step by step in aid of the export needs of the country. It desires to work constantly in co-operation with those who form export associations and also with those who may consider themselves or the public in any way injuriously affected by the methods and practices of such associations.

Where doubt exists as to whether a given method or practice is proper or not, it would seem advisable that the matter be voluntarily presented to the Commission in the early stages, without awaiting its later discovery and possible correction. The second paragraph of section 5 of the Webb act describes the few formalities as to such procedure.

The Commission has prepared blanks, available on request, for making the first and 1919 annual report which enables an easier compliance with section 5 of the Webb act.

Should it become necessary for an export association or for others engaged in the export trade to seek the enforcement of the Commission's power to prevent unfair methods of competition under section 4 of the Webb act the rules of practice do not require formalities in the filing of information or the lodging of complaints, but it is worth remembering that the fuller and more exact the information and references as to proof thereof the speedier the results before the Commission. This is especially true where the charges come from foreign countries where the time necessary for transmission might render the case academic through the sheer lapse of time. Where allegations come from abroad the procedure of the Commission can be more quickly set in motion if the papers are in such condition as to give the Commission "reason to believe" that alleged facts exist. Copies of letters, advertisements, exhibits and affidavits are extremely helpful, as also the names of witnesses and sources of information both in this country and abroad.

As the Commission can proceed on its own initiative, it is immaterial from what source its information is derived, but it is desirable, wherever possible, that for its confidential use the informant be known.

The Commission's investigation of foreign conditions, practices and combinations in foreign countries and its recommendations to Congress thereon will be greatly facilitated by American exporters keeping the Commission informed of their experiences and instances where their export business is restrained or injuriously affected by any matter or in any manner.

The Commission must depend largely for information and facts upon those who are interested in having the Commission correct any tendencies of export associations to artificially enhance or depress prices within the United States or otherwise burden the American public or restrain the commerce of independent competitors.

All mail for the export division should be addressed to the Federal Trade Commission, Washington, D. C., and marked "Export Division."

---

[1] "Discussion of and Practice of Procedure Under the Export Trade Act," Federal Trade Commission, Foreign Trade Series No. 1.

Government Soon to Make Armor and Heavy Forgings

The new naval ordnance plant at South Charleston, W. Va., is now about to begin the manufacture of armor plate and forgings for guns of large caliber, entirely new lines of work for Government plants. The South Charleston plant is a $19,000,000 enterprise occupying more than 200 acres of land. It will be ready for making armor and heavy forgings as soon as the assembling of the necessary working force can be completed. Disturbed labor conditions incident to the war have been responsible for a delay in getting this work started. The new plant is equipped with every modern appliance for the manufacture of its specialties, and will turn out annually 50,000 tons of armor plate, guns, projectiles and miscellaneous ordnance forgings.

Engineers, metallurgists and mill and machine shop men will be interested in the positions which are to be filled in the supervisory and subordinate forces. The United States Civil Service Commission has announced for this plant the need of a superintendent of melting shops at $5000 a year, a superintendent of forge shops at $5000 a year, foreman of heat treatment of armor plate at from $10 to $14.40 a day, foreman of heat treatment of large guns at from $8 to $12.56 a day, foremen of 14,000-ton presses for armor and large-caliber guns at from $11.84 to $13.28 a day, foremen of small guns at $8 a day and foremen of heat treatment of projectiles at $8 a day. Applicants for these positions will not be given scholastic tests in an examination room, but will be rated on their training and experience, weighted at 90 per cent, and their physical ability, weighted at 10 per cent. Detailed information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the local board of civil service examiners at the post office or custom house in any of 3000 cities. Journeyman workmen and helpers should apply direct to the labor board at the South Charleston plant.

Metallography of Aluminum Ingot*

Study of the Microstructure of Aluminum Ingot—Influence of Quality of Ingot on the Resultant Castings—"Differential Group Etching," a Phenomenon Noticed in Etching Aluminum—Tentative Explanation of the Differential Etching

By ROBERT J. ANDERSON†

THUS far not much has been written on the metallography of aluminum, although there have been a few isolated papers on micrography of certain aluminum alloys. The microstructure of aluminum ingot has not been described, so far as the writer is aware. Hence information on this subject may be of interest to the light-alloy industry in particular and to metallographers in general. During the course of an investigation now being made by the Bureau of Mines in the metallurgy of aluminum, it became desirable to examine aluminum ingot in order to ascertain whether the quality of the original metal had any effect upon the quality of aluminum-alloy casting made from the metal. The final answer to that question is not yet in hand, but certain aspects of the metallography of ingot have been studied. Most foundrymen in the light-alloy industry are aware of variations in quality of aluminum ingot; therefore a microscopic method for determining quality should be of some value.

In the microstructure of aluminum ingot, a number of peculiarities still require explanation, and the present article deals briefly with some of these. In addition, this article discusses a phenomenon noticed in etching aluminum which, so far as is known, has not been described for other metals and alloys. This phenomenon, termed "differential group etching" by the writer, is so interesting that it seems to be worthy of description. There seems to be a fixed idea that the internal structure of aluminum is extremely simple; as a matter of fact, nothing could be farther from the truth.

PREPARATION OF MICROSECTIONS

The preparation of microsections of substantially pure aluminum is difficult at best; the numerous light alloys are, however, somewhat more easily prepared. Distortion of the surface is to be carefully guarded against, and heavy pressure in grinding and polishing must absolutely be avoided. Aluminum appears to be amorphized quite readily[1] and the production of a relatively thick amorphous surface layer is highly desirable. Hanson and Archbutt[2] claims that undue distortion may lead to difficulty in etching, since on etching in aqueous solutions the surfaces tend to become covered with a layer of "tarnish" which is troublesome to remove. The section to be examined should be carefully cut out with a hacksaw and then lightly ground flat. This preliminary grinding can be done either with a fine file or by holding the section against a revolving carborundum wheel or a wheel covered with moderately fine emery paper. After this procedure, the section is transferred to French Hubert emery papers of succeeding finenesses; viz., Nos. 0, 00, 000, 0000. These papers are preferably fastened to wooden blocks and the grinding done by hand. To prevent the emery particles from being forced into the surface of the section, the papers are covered with a film of paraffine or wax. The wax permits a high polish to be given to the section.

For final polishing several methods will yield good results. The writer prefers to polish by hand with a good metal polish on a smooth woolen cloth; the polish will remove the scratches from the No. 0000 paper, and the scratches from the metal polish can be eradicated by rubbing the section on another woolen cloth soaked in water. Final polishing can also be done by using fine tripoli before the metal polish, or by using levigated alumina instead of the metal polish. In any case, the polishing should be done lightly so as not to distort the surface unduly. Hanson and Archbutt[3] say they secure excellent results by the use of magnesia powder on a rotating disk covered with a woolen cloth. The disk runs at about 500 r.p.m. They remove the fine scratches from the magnesia by polishing the section then on another disk well wetted with water. The selection of suitable cloth for polishing is very troublesome. The metal polish[4] used by the writer has been previously referred to, and it has been found to be entirely satisfactory.

ALUMINUM INGOT

For commercial purposes, aluminum ingot is usually divided into two grades; viz., grade No. 1 and grade No. 2. The former contains 99.0 per cent aluminum and over, and the latter from 98.0 to 99.0 per cent. There are also some grades of lower aluminum content, and there is a considerable amount of secondary ingot turned over annually. For vital castings which must meet exacting specifications, the lower grades should not be used. The light-alloy casting industry is mainly concerned wth the first two grades. Aluminum ingot appears on the market customarily in two forms; viz., 33-lb. 4-notch bars and 3-lb. 6-notch bars. In spite of the fact that aluminum ingot may contain over 99.0 per cent Al, the physical properties may be very variable. This matter has been definitely proved, and the subject will be more completely dealt with at a later date. The point to be made now is that the chemical analysis as ordinarily carried out is not a complete criterion of quality.

In fact, aluminum ingots of almost identical chemical composition have been found to possess such markedly different physical properties that the analysis has been doubted. The ordinary analysis calls for the determination of copper, iron and silicon, and the difference is said to be aluminum. As a matter of actual fact, this ordinary incomplete analysis is inadequate, gives only a su-

---

*Published by permission of the Director of the U. S. Bureau of Mines. An extract in part from a forthcoming publication.

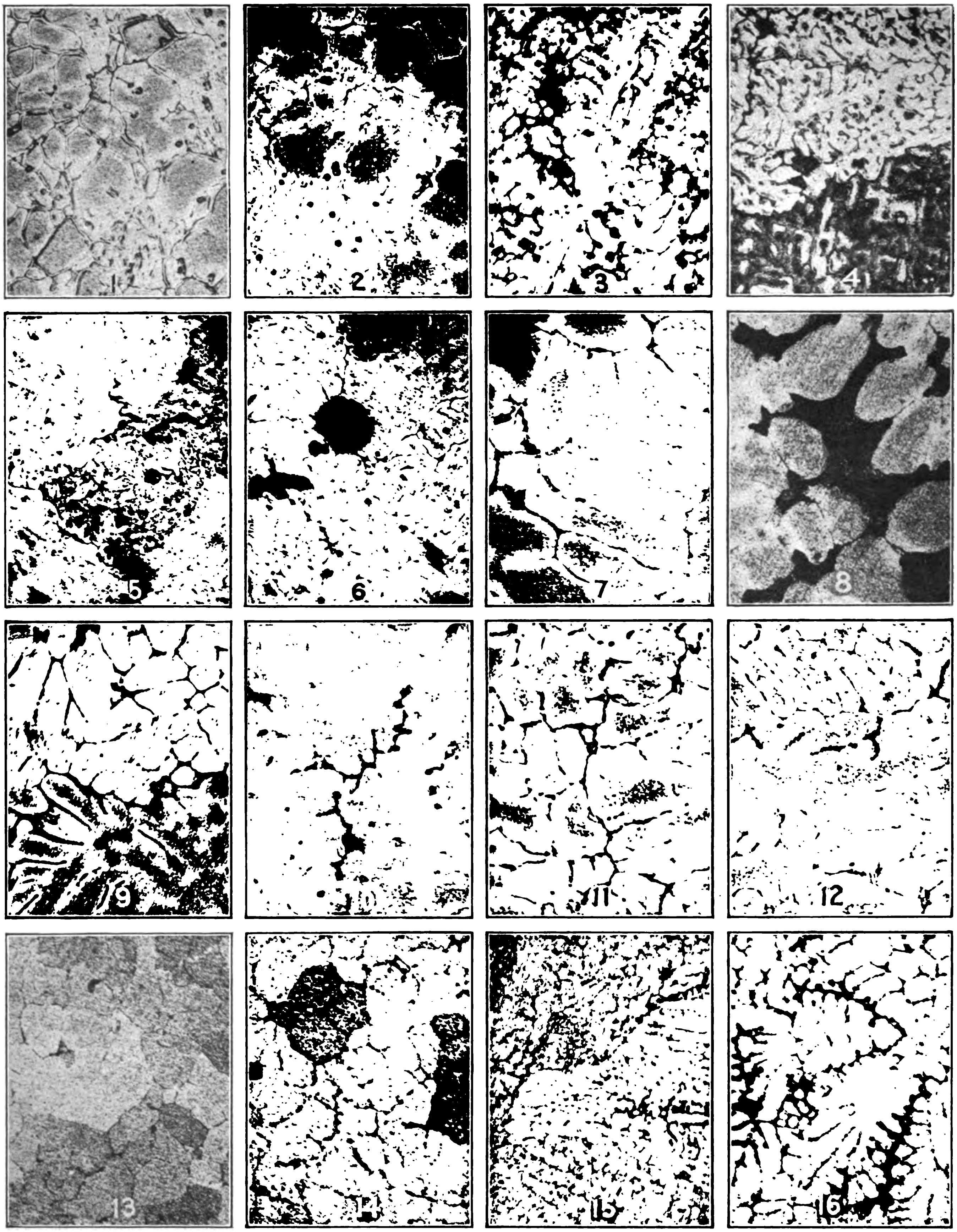
†Metallurgist, U. S. Bureau of Mines, Pittsburgh, Pa.

[1] Anderson, R. J., "The Metallography of Aluminum," *Journ. Frank. Inst.*, vol. 187, 1919, pp. 1-47.

[2] Hanson, D., and Archbutt, S. L., "The Micrography of Aluminum and Its Alloys," paper before the Institute of Metals (London), March, 1919; and the writer in discussion of this paper.

[3] Hanson, D., and Archbutt, S. L., *loc. cit.*

[4] Anderson, R. J., "Metallography of Aluminum," etc., MET. & CHEM. ENG., vol. 18, 1918, pp. 172-178.



FIGS. 1 TO 16

Fig. 1—Sample 1; average structure. Fig. 2—Same as Fig. 1, but at another place. Fig. 3—Sample 2; average structure. Fig. 4—Same as Fig. 3, but at another place. Fig. 5—Sample 3; average structure. Fig. 6—Same as Fig. 5, but at another place. Fig. 7—Sample 20-1; center of microsection. Fig. 8—Same as Fig. 7, but near the piped edge; foreign occluded matter. Fig. 9—Same as Fig. 7, but at another place. Fig. 10—Sample 20-2; center of microsection; foreign occluded matter. Fig. 11—Sample 20-3; center of microsection. Fig. 12—Same as Fig. 11, but at the X edge. All × 75. All etched with HF. Fig. 13—Sample 1; average structure. Fig. 14—Same as Fig. 13, but at another place. Fig. 15—Sample 2, average structure. Fig. 16—Same as Fig. 15, but at another place. Figs. 13 to 16 etched with NaOH; × 75.

perficial idea of quality, and has been the basis of much fallacious reasoning. These and other matters in the metallurgy of aluminum are important and interesting, but the merest mention must suffice here.

MICROGRAPHY

Aluminum, being a metal of relatively low freezing point, has a quite large grain size; moreover, pronounced difference in microstructure may be found in different ingots of the same approximate chemical composition. Not only is that true, but marked differences in microstructure may be observed in various parts of any single ingot, and peculiar etching characteristics have been observed even in single microsections. Realizing the significance of the facts just stated and taking into account the care which must be exercised in preparing microsections, it is not difficult to see that the correct interpretation of aluminum micrographs becomes a rather complicated affair. As has been pointed out previously by the writer, aluminum metallography is in its embryonic stage, and the metal has not yet been subjected to careful microscopic scrutiny by many observers. No doubt a metallography for aluminum will be evolved in time, and that will serve a useful purpose to the light-alloy industry.

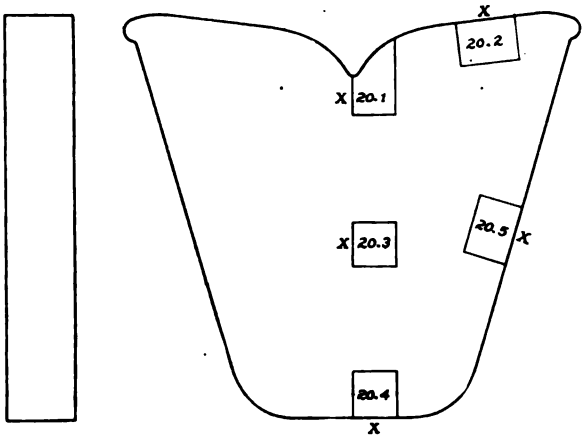


FIG. 17. SKETCH OF 33-LB. INGOT; CROSS-SECTION; HALF SIZE; SHOWING POSITIONS FROM WHICH MICROSECTIONS WERE CUT

To consider for a moment what the quality of aluminum ingot means to the foundries; the practical foundryman wants to know definitely whether the quality of the ingot has anything to do with the quality of the resultant alloy castings. There has unfortunately been a good deal of loose talk on this question; actual corroborative tests have been carried out in only a few isolated instances. For the present, it is sufficient to state that the quality of the ingot assuredly does have some influence on the quality of the resultant castings.

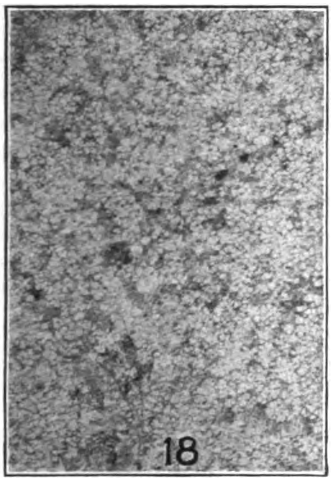
Turning now to a description of the microstructures of certain samples of ingot, reference may be made to Table I and to Figs. 1 to 16, inclusive. Fig. 1 illustrates the average structure of sample No. 1; this was a sample of good tough virgin aluminum. The microstructure is allotriomorphic, and the impurities unless in solid solution are mainly at the grain boundaries. Fig. 2 is the same section at another place; the variation in microstructure within a single section is shown by comparing these two micrographs. Fig. 3 shows the structure of sample No. 2, and Fig. 4 is another micrograph of the same section. The differential etching of groups of dendrites and grains in sample No. 2 is also shown by Figs. 3 and 4, and this matter will be dealt with more completely in a later paragraph. Figs. 5 and 6 show the microstructure of sample No. 3. Samples Nos. 1, 2 and 3 were cut from the center of separate notches of 3-lb. 6-notch ingots. Examination was also made of sections cut from the webs of the same ingots, and the microstructures were reasonably similar.

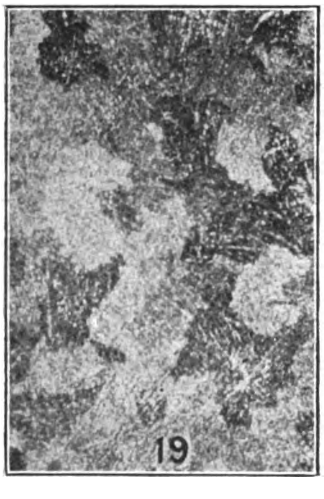
TABLE I.

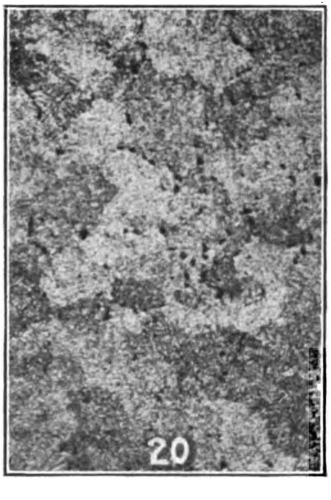
Kind of Ingot	Physically Called	Sample Number	Chemical Composition				
			Cu	Fe	Si	Mn	Al*
Six-notch	Tough	1	0.16	0.37	0.33	Trace	99.14
Six-notch	Brittle	2	0.28	0.72	0.84	0.02	98.14
Six-notch	Brittle	3	0.18	0.40	0.38	0.04	99.00
Four-notch	Tough	20-1 to 20-5	0.20	0.57	0.18	.....	99.05

* Aluminum by difference.

In studying the microstructure of a 33-lb. 4-notch ingot, a section 0.75 in. thick was cut through one of the notches as shown in the sketch in Fig. 17 and the photograph in Fig. 22. The sketch indicates the various positions from which the microsections were taken. Fig. 7 shows the average structure of sample No. 20-1, while Fig. 8 shows considerable foreign occluded matter, pre-







FIGS. 18 TO 21

Fig. 18—Sample 1; average structure. Fig. 19—Sample 2; average structure. Fig. 20—Sample 3; average structure. Fig. 21—Sample 20-3; center of ingot. All × 7. All etched with HF.

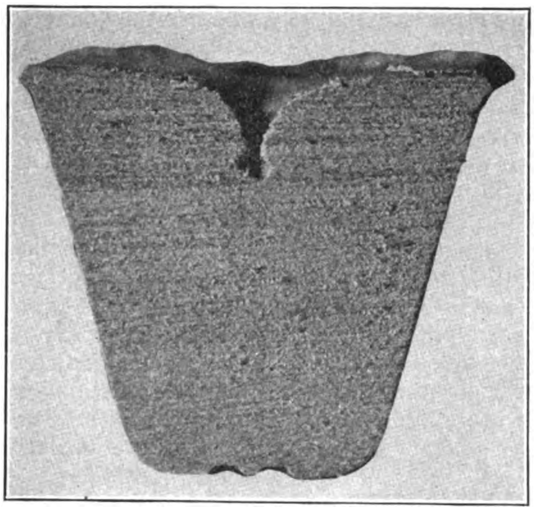


FIG. 22
Sawn section of 33-lb. ingot Samples 20-1 to 20-5 were taken from this section. Half size.

sumably aluminum oxide; the latter micrograph was taken at a point near the pipe. Fig. 9 gives another aspect of sample No. 20-1, and incidentally it also shows differential group etching. Fig. 10 is a micrograph of sample No. 20-2, showing intergranular occluded matter. Fig. 11 is a micrograph of sample No. 20-3. Fig. 12, also taken from sample No. 20-3, may be compared with Fig. 11 for the purpose of showing the variation in microstructure in different parts of a single microsection; Fig. 11 was taken from about the center of the section, but Fig. 12 was taken at a point near the X edge. Samples Nos. 20-4 and 20-5 were contiguous to the chill mold into which the ingot had been poured, and the effect of chill was to cause a tendency toward a dendritic structure on the X edge of these samples. Otherwise, the microstructures were not dissimilar to those already described for samples Nos. 20-1 to 20-3. All the above micrographs were of sections etched with hydrofluoric acid. A few micrographs of sections etched with sodium hydroxide are shown in Figs. 13 to 16 inclusive; these are self-explanatory and may be compared with Figs. 1 to 6 inclusive.

MACROGRAPHY

The examination of microsections of metals and alloys under low powers often yields very instructive results, and it has proved valuable in the study of aluminum ingots. For low-power examinations, the microsections were prepared in the usual manner, and after suitable etching were photographed. Figs. 18 to 21 inclusive are photographs at seven diameters of samples Nos. 1, 2, 3 and 20-3 respectively. Some idea of the relative grain size can be obtained from the macrographs. Those familiar with the interpretation of macrographs might assume that the differently shaded areas in Figs. 19, 20 and 21 are individual grains of large size. Microscopic examination, however, proves that this is not the case. Each of the presumed large grains is found to have a secondary internal structure, and is made up of a number of small grains or dendrites as the case may be. This brings the discussion to a consideration of differential group etching, but before dealing with that it will be better to consider first some other aspects of aluminum ingot; viz., surface appearance and fractures.

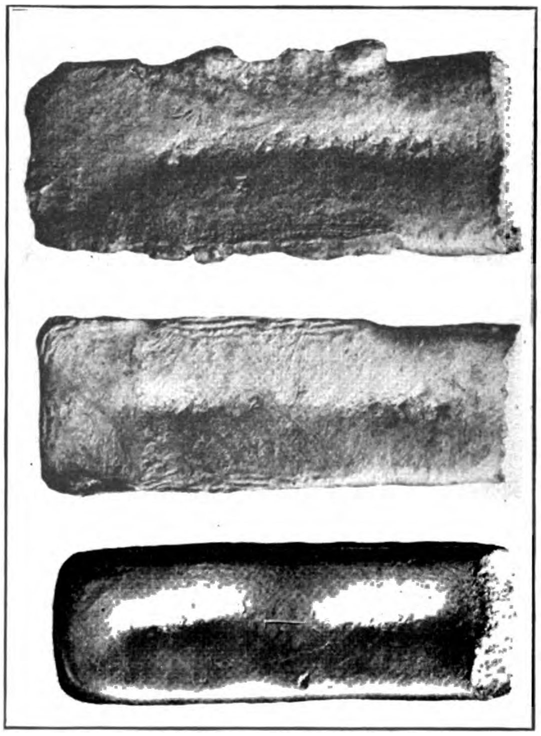
Ocular examination is useful in determining roughly the quality of aluminum ingot. In the foregoing, it has been hinted that the quality of ingot is rather variable and that the physical properties may be quite different in ingots of approximately the same chemical analysis. In Table I, samples have been characterized as tough and brittle, and these terms are used to describe the behavior of the metal in tensile and bending tests. Without going into the matter in exhaustive detail, a distinction between brittle and tough ingot may be made. The tough ingot usually has greater ultimate strength, yield point, elongation and reduction in area than brittle ingot; further, the former will perform better in the bend test, where, for example, a 0.25-in. machined test piece, 2.0 in. long, is bent on itself. Tough ingot may bend 180 deg. and brittle ingot less than 90 deg. As to surface appearance, the brittle ingot is characterized by a rough, pebbly, whitish, frosted surface, and there may also be cracks in the webs pointing to hot shortness. Tough ingot, on the other hand, is smooth, bright and metallic in appearance. Photographs in Figs. 23, 24 and 25 show the upper surfaces of samples Nos. 1, 2 and 3.

FRACTURES

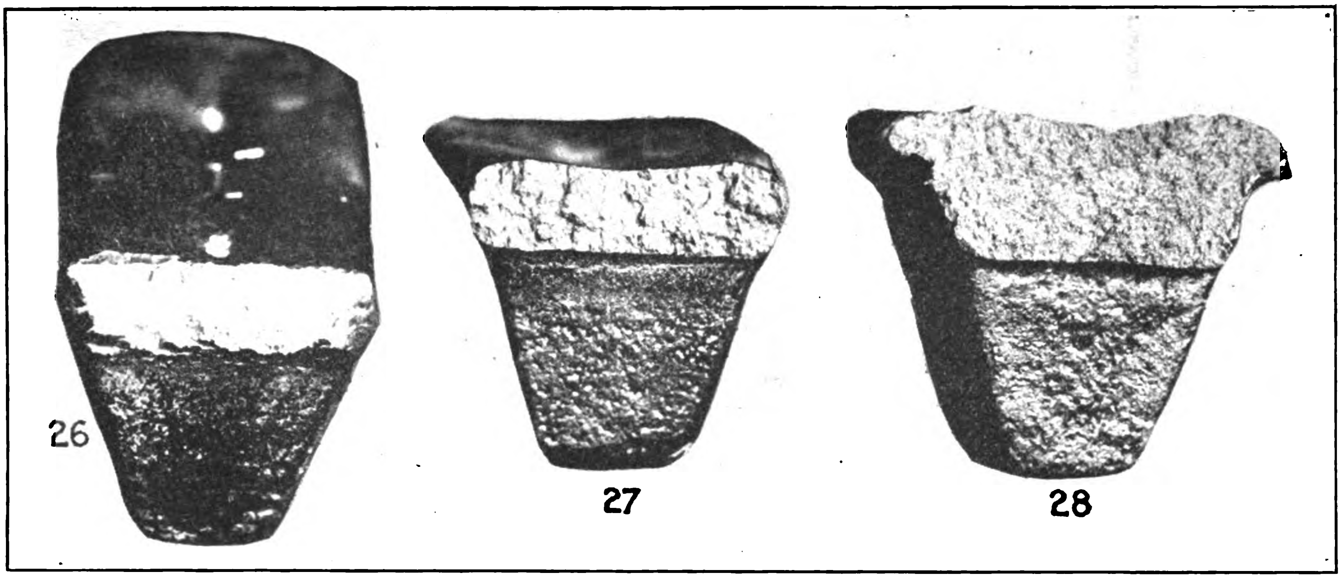
Fractures of aluminum ingot do not generally furnish interpretable data, but may be useful in some cases. Where fractures of patently brittle and tough ingot are compared, the former are characterized as coarse and the latter as fine. Fractures through the webs of samples Nos. 1, 2 and 3 are shown in Figs. 26, 27 and 28. Fig. 29 shows the fracture through one of the webs of the 33-lb. ingot from which samples Nos. 20-1 to 20-5 were taken. In the case of the fractures of samples Nos. 1, 2 and 3, these were effected by bending a 6-notch ingot through one of the center webs until fracture occurred. Sample No. 1 bent through practically 180 deg.; samples Nos. 2 and 3 broke off sharply at about 10-15 degrees.

ETCHING REAGENTS FOR ALUMINUM

The most commonly used etching reagents for substantially pure aluminum are hydrofluoric acid and sodium hydroxide, both in aqueous solution. The con-



FIGS. 23, 24 AND 25
Upper surfaces of samples: 1 (upper); 2 (center) and 3 (lower)



FIGS. 26 TO 28
Fractures through the webs of samples 1, 2 and 3 respectively

centrations may vary widely within limits, but 5.0 to 10.0 per cent solutions of hydrofluoric acid and 10.0 to 20.0 per cent solutions of sodium hydroxide will be found most useful. When it becomes necessary to clean and brighten an etched surface, momentary immersion in concentrated nitric acid, sp.gr. 1.42, or in concentrated chromic acid is recommended.

CONSTITUENTS OF ALUMINUM

The common impurities found in aluminum ingot are copper, iron and silicon. Copper forms a solid solution with aluminum to the extent of several per cent Cu; iron forms the compound $FeAl_3$, which is practically entirely insoluble in the solid state, and silicon occurs quite often as elemental silicon. Silicon and $FeAl_3$ can be distinguished from each other in unetched samples by the gray tone of the silicon as contrasted with the white of the $FeAl_3$. They are more conveniently distinguished by etching with hydrofluoric acid, when the $FeAl_3$ will be seen dark and the silicon lighter. Sodium hydroxide also attacks $FeAl_3$, but silicon appears to be attacked with difficulty by either of these reagents. Hanson and Archbutt[6] have recently described methods for differentiating these constituents, and no further elaboration is deemed necessary here.

ETCHING CHARACTERISTICS OF INGOT

Differential group etching of aluminum has already been mentioned. This is shown admirably by the low power macrographs and better by panorama micrographs. Owing to the large amount of space necessary to reproduce a panoramograph, it is not considered advisable to attempt to show one, but a short description will be given and a few selected single micrographs shown. As stated above, it might appear from a cursory examination of the macrographs in Figs. 18 to 21 inclusive that each differentially etched area represents a single grain or possibly two or three grains oriented nearly the same. On the contrary, this is not so at all; as a matter of actual fact, each presumed large grain has a secondary structure and is made up of numerous smaller grains or dendrites. This group etching of grains has also been observed in some aluminum alloys as well as in substantially pure aluminum. It seems that each group of grains which reflect light similarly into the tube of the microscope is similarly oriented while those of a neighboring group are differently oriented. This means simply group orientation of grains, the orientation changing from group to group. Whether this is actually so or not is not known to the writer, but it would appear to be.

The phenomenon may be observed fairly well in micrographs. In Fig. 14, there is a group of four grains reflecting the same amount of light, surrounded by grains reflecting different amounts of light. In Fig. 15, the line of demarcation from one group dendrite to another can be plainly seen. Other micrographs, Figs. 4, 5 and 9, also illustrate this feature. For the time being, the phenomenon may be referred to as "differential group etching" for want of a better descriptive title. Figs. 30, 31 and 32 are micrographs of sample No. 2 after fairly deep etching with hydrofluoric acid. These are at different positions on the microsection. When properly fitted together and matched, a series of photomicrographs across the entire surface of a microsection gave a sort of panorama of the surface from edge to edge.

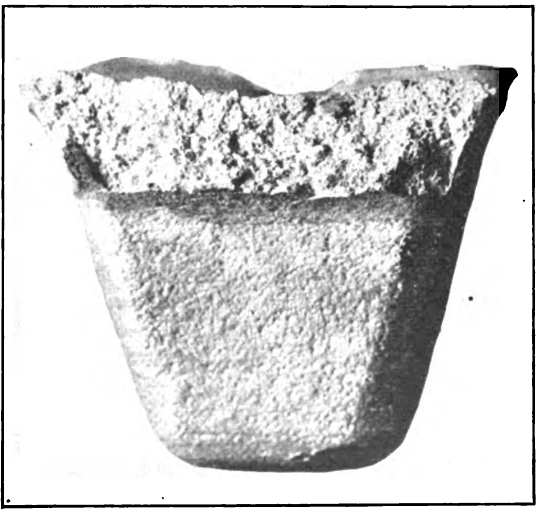
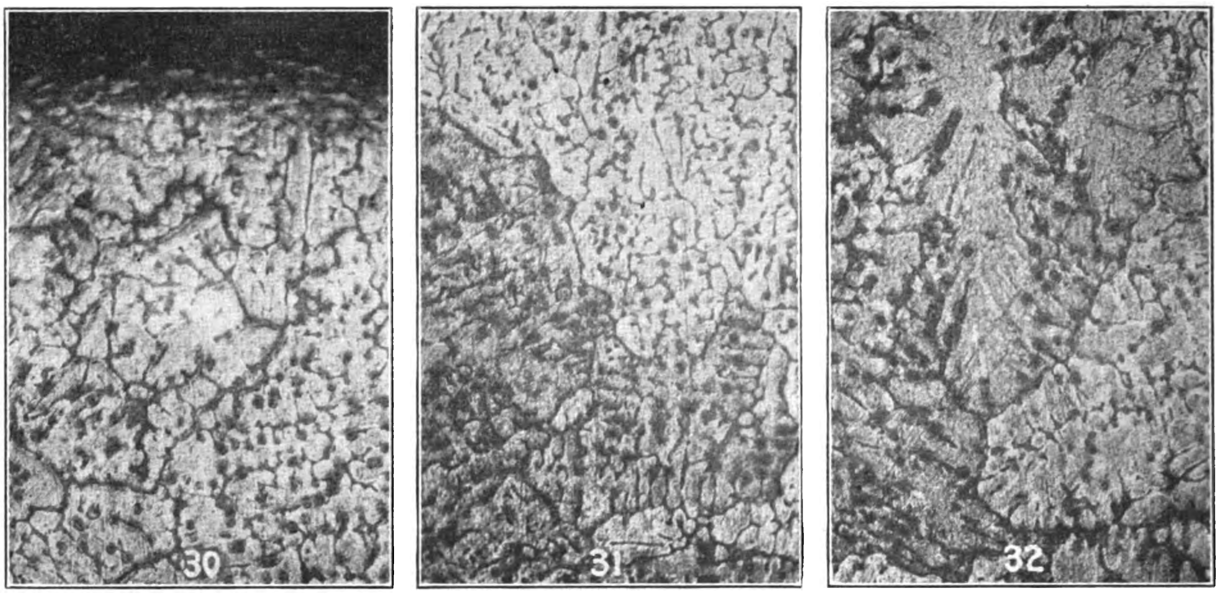


FIG. 29
Fracture through one of the webs of 33-lb. ingot from which samples 20-1 to 20-5 were taken. Half size

---

[6] Hanson, D., and Archbutt, S. L., *loc. cit.*



FIGS. 30 TO 32

Fig. 30—Sample 2, at edge. Fig. 31—Same as Fig. 30, but at another place. Fig. 32—Same as Fig. 30, but at another place. All × 75. All etched with HF

Now, with regard to an explanation of the differential etching, it is the opinion of the writer that a possible tentative explanation may be as follows: When aluminum freezes, it normally freezes so as to form relatively large grains of the approximate size indicated by the groups. With no impurities present, the large grains would represent the true grain size. All the crystalline aluminum, surrounded by its amorphous phase together with part of the impurities, in any one so-called group is oriented the same throughout; all the crystalline aluminum in the next adjoining group is oriented differently. Part of the eutectic-forming impurities are not rejected to the boundaries of the large grains represented by the groups, but are scattered through each large grain. At the moment of final freezing, i.e., when the temperature is so low that no impurities can be liquid, these impurities freeze in position (wherever they happen to be) and thus give rise to a structure within each large grain. Where the impurities form a continuous network, they give rise to smaller grains, and where they are discontinuous, they result in the formation of stringers. The same argument applies to the different orientation of groups of dendrites. An objection which may occur to some is that the phenomenon may be simply due to a stain or tarnish on the surface; this cannot explain the case, because no stain would follow grain boundaries sharply, but would appear as an indiscriminate pattern.

International Union of the Associations of Pure and Applied Chemistry

The Interallied Chemical Confederation, which was organized in Paris last April[1], held its second meeting in London July 14-18. At this meeting the delegates were:

Belgium—R. Lucion, ex-president of the Société Chimique de Belgique; J. Timmermans, professor at the University of Brussels.

France—A. Behal, Member of the Academy of Medicine, professor Ecole Supérieure de Pharmacie; J. Gerard, chemical engineer, general secretary of the Société de Chimie Industrielle; P. Kestner, president of the Société de Chimie Industrielle; Ch. Marie, general secretary of the Société de Chimie Physique; R. Marquis, editor of the *Bulletin* de lo Société Chimique de France; Ch. Moureu, president of the Interallied Council, and of the French Federation of the Chemical Associations, professor at the Collège de France.

Great Britain—F. Frankland Armstrong, member of the Council of the Society of Chemical Industry; Henry Armstrong, emeritus professor of chemistry in the Imperial College of Science and Technology, past president of the Chemical Society; A. Chaston Chapman, past president of the Society of Public Analysts; Henry Louis, professor of mining and metallurgy in the University of Newcastle-on-Tyne, past president of the Society of Chemical Industry; Sir William Pope, professor of chemistry in the University of Cambridge, chairman of the Federal Council of Pure and Applied Chemistry, past president of the Chemical Society; W. P. Wynne, professor of chemistry in the University of Sheffield, president of the Chemical Society.

Italy—G. Pirelli of the Society of Chemical Industry, Milan; Dr. Severini of the General Cyanamide Society.

United States and Canada—Frederick Cottrell, chief metallurgist U. S. Bureau of Mines; Prof. Charles L. Parsons, chief chemist U. S. Bureau of Mines, secretary of the American Chemical Society; Edward W. Washburn, professor of ceramic chemistry, University of Illinois; Robert J. Ruttan, director of department of chemistry, McGill University, Montreal, president of Royal Society of Canada, member of Advisory Council for Scientific and Industrial Research.

The meeting was devoted to the detailed elaboration of the policies and aims of the confederation.

It has been decided that the official name of the Confederation shall be henceforth "Union Internationale des Associations de Chimie Pure et Appliquée" (International Union of the Associations of Pure and Applied Chemistry), and that the provisory business address shall be 49 Rue des Mathurins, Paris.

The following officers were elected: President, Prof. Moureu; vice-presidents, Chavanne, Parodi Delfino, Charles L. Parsons and Sir William Pope; general secretary, Jean Gerard.

The next meeting will be held in Rome in June, 1920.

---

[1] See CHEM. & MET. ENG., Vol. 20, No. 11, June 1, 1919, p. 561.

The Design of Electric Furnaces

Consideration of the Elements of Size and Other Details in the Relation to Operation and the Recovery of Metal, With Special Reference to the Production of Ferromanganese

By R. C. GOSROW

A CERTAIN article in the Dec. 1 issue of CHEMICAL & METALLURGICAL ENGINEERING referring to the size of ferromanganese furnaces, and the relation of size to manganese recoveries[1], touches a subject which is a principal factor in the successful and profitable electric smelting of manganese ores. Such ores may be carbonate, oxide or silicate ores of manganese. Successful and profitable electric smelting refers to the production of a useful alloy of the iron-manganese series for steel manufacture, and other uses; and obtaining sufficient recoveries of the metal from the raw ores as to give a reasonable margin of profit on the operations, from the marketing of the alloy. By any method of obtaining increased recoveries of metal from the ores, it is reasonable to anticipate increased returns from the operation.

The subject first referred to has been so stated that a certain "size of furnace" is considered to be an important factor in obtaining increased recoveries of metal from ores. This is undoubtedly very true, but ambiguous. "Size of furnace" must consider three physical dimensions primarily: length, width, depth. Or more strictly speaking, "height of ore column" should be used in place of "depth." "Size" may imply cubical volume, also any component which may be a factor in its volume. It may also suggest the electrical capacity in transformers connected to the furnace; or it may mean the alloy or metal output. Thus it may be seen that "size" of furnace is rather a meaningless expression.

Two furnaces may have exactly the same cubical contents. One may have a variable in some component of its cubical measure, as compared with the other, and yet both furnaces will not operate efficiently on the same voltage, or respond equally to the same charge. The two furnaces may not develop the same conditions during operation; will not carry the same load; will not operate equally well on the same or equal voltages; and will not produce the same slags, or metals, according to the analytical comparisons. Neither will each furnace produce the same tonnage, providing both have equal electrical connected capacities. I mention these points initially to outline the absolute necessity of analyzing and comparing each dimensional component of the furnace design, and not merely to take the summation or product of all dimensions, and alone compare smelting operations on furnaces of equal holding capacity, or of equal electrical connected capacity.

RELATION OF FURNACE SIZE TO EFFICIENCY

In paragraph 1 of the article referred to, on page 749, the author states that "observation of a number of electric furnaces, varying considerably in size and transformer capacity, and all working under the same conditions, shows the small furnace to be much more efficient in operation than the large furnace."

After reading the above statement, the question one would ask is, "Why is the small 'size' of furnace more efficient in operation?" Is the efficiency referred to rated on the kilowatt-hour consumption per ton of metal of standard content produced, or on manganese recovered in the alloy? It may be both. A low kilowatt-hour consumption may go hand in hand with a high recovery of metal, and vice versa. A low recovery of metal means larger slag volume and greater tonnage of ore to be put through the furnace to keep up the production, increasing power consumption considerably per ton of salable alloy produced.

ADVANTAGES OF "SMALL SIZE" FURNACE

As the "small size" furnace is more carefully charged than the "large size" furnace, the charge may be better distributed over the top area of the furnace, and be given more stoking, if such be necessary. As the charge is weighed in less quantity, more careful weighing may be accomplished. Also with the lesser weights of charges, and mixing of charge ingredients, errors in weighing cause greater fluctuations in smelting operations.

Usually mechanical features of strength require greater electrode areas than the actual load requirements of the furnace would specify. This means better heat distribution, and less current density in the electrodes, with less voltage drop in the electrodes. By increasing electrode areas, increased water cooling in the holders may be accomplished, directly keeping the electrodes cooler above the charge line.

As the "small size" furnace can be better manipulated, a faster furnace results, with increased efficiency and economy in operation over a slower furnace. With a small crucible the furnace may be more thoroughly drained of metal at taps, and slag and carbide accretions controlled and readily removed.

The remarks here made that are relative to a comparative "small size" of furnace do not in any way validate these points and establish them. Frequently operations cannot bear a number of small units and their increasing number alone would eliminate them as a commercial factor. Larger units in equipment frequently solve a problem not only of metallurgy but of finances. Larger units where successful are much desired to small units.

CAN LARGE FURNACES BE EQUALLY EFFICIENT AS SMALL?

The question may now justly be put, "Why cannot the 'large size' furnace be equally efficient, metallurgically, electrically and from a dollars-and-cents viewpoint, as the 'small size' furnace?"

It must be considered that, "large" and "small" being comparative adjectives, it would be more to the point to describe two furnaces for comparison as being "twice the length," "one-half the depth of ore column," "one-third the width," "one-quarter the volume," etc.; these statements then being based on any dimensional component of the furnace volume: its electrical equipment, electrode sizes and areas and their relation to furnace crucible area, the rate of power input, and metal production, etc.

---

[1] "Size vs. Recoveries in Ferromanganese Furnaces," E. S. Bardwell. CHEM. & MET. ENG., Vol. 19, No. 11, p. 749, Dec. 1, 1918.

During the past eight years the writer has been actively and intensively engaged in the electric smelting of manganese, silicon, chromium, tungsten and molybdenum ores for the production of their ferro-alloys, also the electric smelting of iron ores for basic and foundry pig-irons, and has continually made a careful study of the furnace conditions on each, endeavoring to determine those factors which under some instances gave failures, while in others marked success. These conditions were encountered when smelting the various ores and in various designed and proportioned furnaces, with varying electrical capacities. I use the term "proportioned" in preference to "size." It was demonstrated that the proper proportioning of the several dimensions of a furnace, to do certain reduction work on ores by electric heating, must be determined by careful study and observation, and one must build the furnace and equipment into those conditions which exhibit themselves during operations.

Experience With a Large Furnace

I desire to narrate an experience while operating two 15-ton rated ferromanganese furnaces in 1914. The one furnace was constructed after an ideal, or rather a dream. I use the term "constructed" because the furnace was not "designed," but the structural details were drawn up and the job assembled, with the result that there was on the ground a steel shell brick-lined, electrodes and holders, buses and transformers, and a great variety of electrical paraphernalia. The furnace was erected when I arrived, and it was ready to operate.

The furnace shell was made of ⅝-in. steel plating, heavily reinforced and braced, and was a good piece of work. The shell measured 27 ft. inside in its length, with curving side walls 12 ft. across at the center, and 10 ft. at the ends; and from the bounding angle around the top of side and end wall plates to the bottom plate approximately 12 ft. 6 in. This was indeed a tank. An 18-in. brick lining was put in all around and an 18-in. bottom. This lining and bottom in the shell gave a crucible of 24 ft. by (average) 8 ft. by 11 ft., having a cubical volume effectively filled with charge of 1900 cu. ft. The four electrodes were 12 in. in diameter Acheson graphite, with threaded cone joints. The transformer installation consisted of six 750-k.v.a. single-phase General Electric transformers, two on each phase connected in parallel. Copper buses and electrode holders were sufficient for maximum loads carried. The electrical equipment on this installation was well laid out, and caused no interference, but it was not possible to get any good measure of this electrical capacity into that furnace full of charge material.

This furnace was considered a "large" size furnace. From the standpoint of smelting capacity it was a "small" size furnace. Here we have two "sizes" for the same furnace, each dependent on particular features of design, production and the ratio of certain component parts to one another, but such statements are vague and ambiguous when speaking of "size."

I wish to analyze some of the details of this furnace:

L—Length inside lining	24 ft. 0 in.
W—Width inside lining	8 ft. 0 in.
D—Depth of ore column	10 ft. 0 in.
V—Cubical contents crucible (effective)	1920 cu.ft.
A—Crucible area	192 sq.ft.
E—Electrode area	3.14 sq.ft.

Existing ratios of components:

$\frac{L}{W}$	3 to 1
$\frac{A}{E}$	61.2 to 1
$\frac{D}{W}$	1.25 to 1

Voltage normally carried in buses	80 volts
Max. load carried in furnace any time	1,800 kw.
Max. load carried per cent of total time	11 per cent
Approx. current at 80v., 1800 kw., 0.85 p.f	19,100 amp.
Approx. current per middle phases	11,000 amp.
Approx. current per end phases	5,500 amp.
Approx. current per cubic foot of charge	10 amp.

Electrodes connected in delta.
Production: three tons per 24 hr.

From the above figures we may note, the furnace, filled 90 per cent of its effective volume with charge, amounts to 1900 cu.ft. Then from power input we may calculate 10 amp. per cu.ft. of charge, or approximately 10 amp. per 180 lb. of charge. If it were possible to distribute evenly the heating effect of this current throughout the furnace, it can be readily appreciated that a minimum amount of work would be done. The net result would be small volumes of fused charge probably reduced near the electrodes, and large volumes of unfused charge, not melted or reduced, spread throughout the volume of the charge at low levels in the furnace. This anticipated result was verified. In proximity to the electrode tips high temperatures were developed. As the furnace hearth was conducting, the path of least resistance to current flow was straight down to the bottom, consequently rapid and excessive heating occurred in the areas directly under and around the ends of the electrodes. It was therefore only possible to carry loads (electrical) when fused and reduced material made contact between the electrodes and the furnace bottom. The electrodes were spaced 66 in. center to center. This apparently was too great a distance, at the then operating voltage, for a continuous passage of current from one electrode to the next, and to provide a continuous heated path for current to pass from one phase to the next, to give proper phase balancing, and also to develop the temperature for smelting. The conditions, then, represented a molten pool under each electrode, contact with the hearth, passage of current to the next pool through the hearth and to the electrode, completing the circuit as the current travel may be. But areas midway between the electrodes were cold, semi-fused non-conductors, and insulated each electrode, electrically and thermally, from the next.

Thermal Influence of the Electrode

Here, then, was a phenomenon exhibiting the heating influence which an electrode has over an area affected by it. In order to classify and distinguish this phenomenon I have termed it the "thermal influence of the electrode." I would define the expression as being the effect of the current at the electrode and contact, and the influence which the electrode has in distributing this heat to a surrounding area. This may be determined experimentally for any voltage range, with any nature of materials constituting the charge, and for any power loads, but depends principally on the voltage between the electrode and the charge or the hearth, and the nature of the charge, electrically and physically. With furnace conditions so abnormal that only light and uncertain loads could be maintained in the furnace, and a low ore column being necessary, the loss from volatilization was certain to be high. Figures from periodic capitulations showed slag and volatile losses of manganese to run from 22 to 32 per cent. These figures show very poor recoveries compared to others on the same ores. The reasons therefor are apparent.

INEFFICIENCY DUE TO IMPROPER PROPORTIONING

The various related dimensions of this furnace lacked the proper proportioning to develop the best efficiencies in the operations. As the results aimed for by a proper mixing of the charge were lost, due to the frozen areas in the furnace, the proper reductions did not take place, accounting for the high manganous oxide content in the slags. Some of the slags ran as follows:

MnO Per Cent	CaO Per Cent	SiO_2 Per Cent
28.0	38.7	28.3
22.3	37.9	30.8
27.4	35.1	29.3
27.0	28.5	36.1
24.0	35.8	33.5

These represented weekly averages, and running on irregular operations. These erratic smelting conditions caused high volatile losses, running as high as 9 to 14 per cent. But volatile losses may be controlled only to a moderate figure. It is not possible to reduce them to zero. This furnace was run for 8 days only, and produced 24 tons of 80 per cent ferromanganese alloy. The recovery was 62 per cent of metal. Maximum load for 11 per cent of the time was 1800 kw. Eighty-eight tons of manganese ore averaging 44 per cent Mn and 18 per cent SiO_2 were smelted. This was a "large" size furnace in all respects except production and power input. It had large dimensions only. But this was not its real and only fault. The real and primary cause may be attributed to the design and lack of care and attention to the proper proportioning of its component parts. Such an inefficient piece of apparatus makes a poor but effective comparison.

The second furnace was of similar constructional details, but in its design there were incorporated those metallurgical principles of detail which the apparatus was required to carry out. Careful attention was given to the details of properly proportioning those component parts which were to make up the furnace. It had developed in my experience to regard carefully certain essential ratios in furnace details as all important in the design. I had also observed the effect of electric heating in straight resistance type ore smelting furnaces, and had learned to appreciate the effect of heat caused by the current from one electrode, and heat caused by the current from an adjacent electrode. This particular relationship as before mentioned I have termed the thermal influence of the electrode. This heat influence may be large or small depending of course on the voltage drop between the electrode and the charge or the furnace hearth, the power input and the nature of the materials in the charge. As the mathematical value may be expressed in terms of the electrode diameter, this is primarily a factor. From the value of the thermal influence of the electrode, under certain conditions, we may find a value representing the ratio of electrode area to area of furnace crucible.

AREA OF THERMAL INFLUENCE OF ELECTRODE

To illustrate this statement: It has been determined by observation and measurement that the area of thermal influence of a 12-in. diameter graphitized electrode in an ore smelting furnace, running at 60 v. on the buses, 1800-kw. load, could be represented by the formula:

$$AT = \frac{(d \times a)^2 \times 0.7854}{144}$$

in which

AT equals sq.ft. area of thermal influence of the electrode.

d equals electrode diameter in inches.

a equals a constant; depending on voltage, nature of of materials in the charge, etc. For manganese, chrome, and iron smelting this value has been found to be 2.5 to 2.75, and using graphitized electrodes.

The diameter of the area of thermal influence may be also found by:

$$DT = \sqrt{\frac{AT}{0.7854}}$$

Considering the plane of the thermal influence area to be horizontal, it is now possible to determine the proper spacing of the electrodes, and also to fix the area of furnace crucible and the ratio of furnace area to electrode area. We now have a starting point for assembling the several factors entering into the design of the furnace. As the energy consumption per ton of product, and desired production must be known, these factors must be balanced against the former for electrode area and furnace crucible area. The proper spacing of the electrodes is an important feature and directly concerns efficiency of operation in any "size" of furnace. It is primarily essential to have a furnace operate with a cool top and a hot hearth. To obtain this the electrode spacing must be such as to utilize the thermal influence of each electrode at the plane of electrode contact, in the smelting zone of the furnace. Also the electrodes should be sufficiently far apart to increase, as far as possible, furnace capacity for charge. They must also be properly spaced to eliminate any "jumping across" of current from one electrode to another in the upper part of the furnace and in the unsmelted portion of the charge. By considering these factors, electrode spacing will be ultimately fixed.

EFFECT OF DEPTH OF ORE COLUMN

The proper depth of ore column and length of electrode to carry are very important factors, often given little thought and consideration, because their causes and effects are not understood. Many furnaces which I have examined and studied showed no reasons for making these dimensions as they were. The proper depth of ore column must bear a definite relation to the material being smelted and to the metal produced. The height of ore column directly bears the same relation. In smelting chrome and manganese ores lower ore columns are used than are in smelting iron ores. This is due to the difference in reducing reactions and slag purifying of the metal; also in manganese and chrome smelting no well of metal is maintained as in iron smelting.

In the electric smelting furnace, reducing gases are not depended on or utilized for ore reduction in the descending column. But as reduced gases are not utilized for reduction long ore columns are not necessary, and also too short ore columns are not desired. But in the "small" capacity furnace operated by hand, shorter ore columns may be used, because the accumulation of heat on the hearth is not so great as in the "larger" mechanically operated furnaces. We must also be guided by the mechanical strength of carbon and graphitized electrodes, and the economy of carrying average lengths of either in the furnace.

The depth of ore column may not always be determined solely by metallurgical conditions. The designer may desire to carry a height of ore column inconsistent with strength of electrodes or length of electrodes obtainable from the manufacturers. He must be guided by a combination of conditions.

In the case of graphitized electrodes, good mechanical joints may be made and a joint having at least 85 per cent of the strength of the solid body of the electrode may be obtained. This refers to transverse strength of the joint and the material. Ungraphitized carbon electrodes do not exhibit such good mechanical properties in the joints. The pressure of the charge against the electrodes and the movement in the charge largely determine length of electrode, by gaining the requisite mechanical strength.

Relation of Furnace Design to Life of Refractory Lining

A most important subject to a smelter is usually linings, pertaining to the life of the refractories in the furnace. The proper design of furnace has considerable effect on refractories, and we have another important component of furnace design. It is the distance from the front and back walls of a furnace to the electrodes (considering the electrodes in a straight line with the furnace long axis). This proper proportioning calls for a close study of past furnace operations on various loads, metals, ores, charges and rate of smelting. My experience has shown that a furnace inner-wall-line should be just close enough to the electrodes as to allow charge to fuse on its surface, but yet be far enough from the electrodes to interfere with fluxing or melting of the wall refractory. This may be controlled to a large extent by using water-cooled wall plates so that the fusing may be stopped by the rapid conduction of heat as soon as this condition is approached. In ferrochrome smelting this practice is of considerable benefit in maintaining the linings. The bad results of having the walls too far away are also numerous. The bad results may be exhibited by a cold tap-hole; running of the unfused charge into the tap-hole at time of tapping metal; inactive charge in the furnace not working down and being smelted, causing scaffolds and hangups; excessive heating of the one wall. On the side of the furnace from which tapping is done, the cooler wall conditions should result from the unfused charge constantly moving on this wall and the charge being shifted when tapping of metal takes place. On the other hand, it may also be the hotter wall, because the hot charge would follow the flow of metal, which would run to the tapping hole or notch, The opposite wall, then, would now exhibit the hotter conditions due to the charge lying dead on this wall.

If the imagination may be used, we can say the following conditions exist: As before stated, each electrode has a certain area over which its heating influence is exhibited. Consider three or four electrodes in a straight line, along the long axis of the furnace shell. Consider the thermal influence areas to be circular or nearly so, as the electrode is circular. We would then have under proper conditions three or four circular (or nearly so) areas, tangent to or interlocking one another; in other words, a hot area continuous through the center of the furnace, due to overlapping of heated areas.

As the thermal influence areas also extend at right angles to the long axis of the furnace, its effect is extended to the front and back walls, and tangents to such areas would be the wall line. The width of the furnace may be so determined, and the ultimate results on the wall refractories may be determined. It must not be considered that the location of front and back walls from the electrodes is as vitally important along the top of the charge. Here no fusion or reduction takes place, but the plane of proper fixing of these distances is in the fusion zone only. But, as will be mentioned later, straight walls are desirable, and not walls giving enlarging or reducing forms to the furnace shell.

Details and Proportions of Another Furnace

This second furnace was designed with the consideration of points such as those previously mentioned. It was a "large" size furnace, in cubical volume, in smelting capacity, metal production and power input. I desire to attach some of its details and proportions:

L—Length inside of lining	15 ft. 6 in.
W—Width inside of lining	7 ft. 6 in.
D—Depth of ore column	7 ft. 10 in.
A—Area of crucible	116 sq.ft.
E—Area of electrodes (4, graphitized)	3.14 sq.ft.
V—Cubical contents (charge)	908 cu.ft.

Existing ratios of components:

$\frac{L}{W}$ .... 2.07 to 1

$\frac{A}{E}$ .... 37.0 to 1

$\frac{D}{W}$ .... 1.04 to 1

Voltage normally carried on buses	60 volts
Max. load 95 per cent of the total time	1,650 kw.
Transformers, 3 750 k.v.a., delta connected	Single phase.
Approx. current at 80 v., 1650 kw., 0.88 p.f.	24,000 amp.
Approx. current per middle phases	14,000 amp.
Approx. current per end phases	7,000 amp.
Approx. current per cu.ft. of charge	27 amp.
Approx. current per 180 lb. of charge	27 amp

Production: 16 tons 81.5 per cent Mn ferromanganese alloy per 24 hr.

REPRESENTATIVE ANALYSES OF ORES SMELTED

Oxide and Rhodonite Ores. On Dry Basis

	Per Cent
Manganese (metallic)	40 to 51
Silica	24 to 10
Manganous oxide	16 to 9.5
Manganese dioxide	52 to 68
Ferric oxide	3 to 1.75

SLAGS PRODUCED

High and low manganese contents

MnO	SiO_2	CaO
16.3	36.0	41.3
13.55	35.4	44.3
12.1	36.8	44.6
14.3	36.0	44.4
14.4	42.0	40.2
14.25	39.0	41.9
11.8	37.2	45.1
14.6	36.8	41.7

The metal account over a 90-day period showed:

	Per Cent
Manganese in the alloy	79.55
Manganese in the slag	15.65
Manganese in dust and volatile losses	4.80
	100.00

Effect of Design on Heat Concentration

This second furnace, then, both in features of design and in operation, was much superior to the first one. The current density if evenly distributed throughout the furnace calculates to 27 amp. per cu.ft. of charge, while in the first furnace this value showed only 10 amp. This figure, while not being of any great value in this significant use, means considerable when it is considered that every cubic foot of material is acted upon by about two and one half times the current and heat that the first furnace shows. These values must not be taken in their mathematical value, but in their indicative terms. It also gives a fair value for the comparison of two furnaces, to arrive at a relation for heat input. In the second furnace there was accomplished a greater concentration of heat, rather than a greater distribution of heat. The value for current density interprets this condition. Even heat distribution and also heat concentration may be accomplished with the proper design of the apparatus and proper proportioning of its component details.

The conditions governing voltage ranges in an ore smelting furnace are not a direct comparison to those encountered in the steel furnaces using arc and arc-resistance heating. The smelting furnace here referred to uses both arc and arc-resistance for the generation of its heat. It may be desired to change the voltage during the operations; this would necessitate variable voltage regulation on the transformers; or it may be desired to use a fixed voltage on the transformers and vary the resistance in the furnace. The subject of the proper voltage for best recoveries and proper operating conditions does not appear to be the question to settle. The question appears to be: With any voltage on the secondary side of the transformer, within reason of the points previously referred to on this subject, what are the conditions which can be obtained to get the best results from the given voltage? The matter of a few volts variation is nothing here nor there. Usually an approximate voltage is determined on to build the equipment to, often determined from some past experience, etc. It is not necessary to pay great attention to voltage range, and to spend large sums of money to build special expensive equipment to get a certain desired voltage. This may and can be taken care of by other means, and the subject of adjusting the furnace conditions to a transformer's secondary voltage may be taken care of. This of course refers to the moderate and not the extreme.

INFLUENCE OF REDUCING MATERIAL USED

In using the various reducing materials—coal, coke, charcoal, petroleum coke, gas carbon briquettes, etc.—and using any one of them in a range of sizes from ¾-in. up to 2½-in. ring size, it will be noted that a varying set of conditions exists for varying size of the same material and for each different material. To eliminate unnecessary repetition here, I refer to my article on "Coke as Reducing Agent in the Electric Smelting Furnace," METALLURGICAL & CHEMICAL ENGINEERING, Vol. 14, No. 12, June 15, 1916, Page 691 et seq. Here only two reducing agents are compared, coke and charcoal. But the conditions produced by the use of any of these materials bear directly on furnace operations. Such conditions may be defined as varying voltage by varying the resistance, power efficiency in the furnace, and recovery of metal in the alloy, and manganese content in slags.

It might be stated here that a transformer with the voltage ranges 30-60 or 30-60-90 would meet all requirements on a smelting furnace. A fixed voltage may be used on the secondary buses, and internal resistance of the furnace varied. By a change in the reducing material used, a change in the nature of the charge may be effected, consequently a change in the electrical characteristics of the charge is effected. Also a change in the size of the material effects a change in the electrical conditions.

In one furnace producing ferromanganese, fine coke (1 in.) continually produced carbides, while coarse coke (2½ in.) gave good reductions and produced a minimum of carbides in the slag, with increased alloy production. Lump charcoal also promoted better conditions. In another instance in producing foundry-pig, 1-in. coke made good foundry-iron (2-2½ per cent silicon). When using coarse 2½-in. lumps, a low silicon pig resulted, under 1 per cent silicon. These operations took place in making electric furnace pig iron on 30-ton furnace operations direct from ore in the furnace. The component details of furnace design also played a large part here, as the electrodes were probably too close together, allowed a large part of the current to jump across, and made the furnace top very hot. The fine coke did not exhibit these details, but it caused a very hot furnace and caused the formation of considerable carbide in the bottom of the furnace. These carbide accretions soon built up and caused hang-ups, with the result of burning out side and end walls. Water cooling was resorted to, and while it made considerable difference on the side walls, did not help the interior of the furnace. One reason for the accumulation of these accretions at the point where they did occur was a contraction in the area of the furnace, causing excessive heating to a small volume of charge here and producing compounds of high heats of formation. Restrictions in shape and dimensions are bad features in an electric furnace and should be avoided unless for vital reasons.

COKE AND CHARCOAL IN DEEP AND SHALLOW FURNACES

In two different furnaces running on ferromanganese, having the same bus bar voltages, same ore and reducing material, neither furnace had the same height of ore column, or the same spacing between electrodes. The deeper furnace—9-ft. depth of ore column, 60-in. spacing of electrodes—worked better on coarse coke. The other furnace—7-ft. depth of ore column, 40-in. electrode spacing—worked better on coarse charcoal. From my article referred to this becomes apparent. The shallow furnace worked well on 1-in. coke, while the deeper furnace could not be run on 1-in. coke. By increasing the voltage on each furnace and connecting the deeper furnace in star, the only alternative was a higher ore column. With higher voltages, my opinion leads to the use of higher ore column. Higher ore column means more electrode length to carry, with increased breakages. I once decided to investigate the relation of voltage to electrode breakage, and now believe that high voltage meant high ore column and consequently more electrode breaks. Undoubtedly the resistance of electrode material has something to do with electrode weakness, but in such conditions as an electrode smelting furnace runs under, this would be a minor cause.

Another point which has considerable bearing on furnace operations and recoveries is the method of charging the furnace. As referred to in the beginning of this article, a furnace controlled and worked entirely by hand can be more easily charged than a furnace requiring mechanical appliances for loading and charging. This is of course due to the better manipulation of the charge by the operator. One of the essential conditions to be desired in charging a furnace is to maintain the charge level on top of the ore column. This may be obtained in two ways, one by distributing the material by hand-rabbling, and one by properly spotting or placing the charge when dumping.

ADVANTAGES OF HAND-CHARGING AND RABBLING

The operation of spreading the charge by hand-rabbling becomes increasingly difficult as the areal dimensions of the unit and size of the charges increase. This is apparent. If mechanical pushers are used on the top of the charge, other mechanical difficulties arise. Also the desirability of performing hand operations on a furnace is of considerable advantage. Most of the charging may be done by a shovel and hand labor. In this way 20 lb. may be the maximum load thrown on the charge at one time and place. This load may be placed exactly where desired. The small unit charges may be well mixed beforehand. The charges do not fall from a great height onto the ore column, and do not develop a tendency for the charge to pack. Light loads of charge and low drop make a loose ore column and good smelting conditions. Stoking is another essential. The hand-operated furnace can be more successfully stoked to prevent crusts from forming and causing the charge to keep moving down and not be allowed to become dead in the furnace. The accumulation of dead charge in a furnace will at once cut down production and recoveries. As the metal bearing materials incipiently fuse and crust the furnace, loss of metal results, and all calculations are thrown out. Heavy wall crusts affect linings, by the more rapid deterioration of side walls. In all the above respects the hand-controlled furnace shows points of superiority in operation, recovery and production.

In furnaces having areas and volumes where hand labor for charging has to be eliminated, mechanical appliances must be used. The operation of some of these mechanical appliances has considerable to do with production and recoveries in the furnace. As the majority of such methods dump the charge from above and usually from 8 to 12 ft. heights and require rather large unit charges, a decidedly different set of conditions exists from that of charging small mixed charges by the shovel from a low fall. The large charge (500-1000 lb.) falls with considerable impact. The heavier material of the charge, falling with greater impact and settling first, upsets the proper feeding of the materials. This condition usually upsets the careful mixing which may previously have been accomplished. Also ore or limerock may fall around the electrode, when the opposite may be desired, and carbonaceous material falls next to the walls. By the carbon material falling next to the walls the temperature of the walls is considerably increased. This also results in areas in the center of the furnace being impoverished in reducing material. Also one part of the furnace may be running faster than another part and it may be necessary to place charge where most needed. This necessitates some rabbling and distribution of the material over the furnace top. With an 18 by 10-ft. furnace top area, this is inefficient at best. In rabbling, a workman usually draws or pushes more of the light material than heavy material, consequently uniformity throughout cannot be obtained. These conditions are prime effectives on production and recovery in an electric smelting furnace. These conditions also eliminate some of the smooth operations, such as occur on furnaces of lesser dimensions, volume and capacity. They will often account for otherwise unexplained factors.

COMPARISON OF METHODS OF CHARGING

It might be of interest to mention two methods of charging used on 20-ton alloy furnaces (20 tons of alloy per day). One method was by straight drop, and the other by a movable spout.

In the straight drop method, stacks were built between electrodes, and the charge dropped directly from above. The drop was about 11 ft. It was necessary to drop at least 500 lb. of mixed charge at one time. The charge descended on the top of the ore column with heavy impact and packed the material densely around two adjacent electrodes, as the stacks were between. Then by rabbling usually the light charcoal was pushed or pulled away, and only ore and limerock were left around the electrodes. This condition, it was seen, soon upset furnace conditions and a change was necessary. The charges were then dropped, charcoal or coke first, and then ore and limerock. This rectified matters to a certain extent, but it required more labor on the feed floor, and caused considerable loss of charcoal, by dusting, and disintegration of lump charcoal when the ore fell upon it. The whole method of charging was then changed, having proved unsatisfactory.

A movable hopper over the furnace running on a track had an outlet into a long spout, which, being on a swinging joint, moved forward and backward. When a charge was dumped from the scale car into the hopper the spout was moved forward and backward, thus distributing the charge from front to back of the furnace. From the lip of the spout the charge fell about 3 ft. to the top of the ore column. As the deflection plate in the hopper was set at about a 45 degree angle, the velocity of the charge was checked from a straight-down fall, and as a result the charge fell with considerable less impact from the lip of the spout. In this way charcoal or coke could be fed separately, properly distributed, and ore following could be also be distributed. A minimum of rabbling was necessary and operations soon showed the merits of the change. The results were uniform smelting, absence of heavy crusts in the furnace, less labor necessary on the working floor, cooler top, better cooling of side walls, less dust in charging, less disintegration of charcoal.

The continual addition of 200 to 400-lb. charges is to be preferred to 700 to 1000-lb. charges dumped at long intervals of time. In this instance again, dimensional features and methods of meeting increased capacities control recoveries and production of metal. Also, the 16-ton furnace may be made equally efficient as and more efficient than the 5-ton furnace, by proper mechanical appliances.

While the method of charging a furnace is largely dependent on the quantity of charge required per unit of time, the capacity of the furnace usually decides the method to be used. With the dimensional features of the furnace already decided upon, the method of proper charging should be given careful consideration.

RELATIVE METAL RECOVERIES FROM DIFFERENT ORES

I also wish to refer here on the relative recoveries of metal from smelting carbonate ores, compared with smelting the oxide and silicate ores of manganese. Carbonate ores carrying not over 8 per cent silica should give lower losses from slag loss than silicate ores. As the manganese oxides are not chemically combined with silica to such large percentages in the carbonate ores, less slag losses would occur, the reason for this being freedom from rhodonite in the rhodochroisite ores.

In the silicate ores (rhodonite) the lime replaces some manganese oxide, forming lime silicates. But as lime replaces some manganous oxide, all replaced manganous oxide is not reduced by carbon to manganese. A large per cent of the manganous oxide passes again into solution with the silicates of lime and escapes reduction, forming double silicates of lime and manganese. Therefore on rhodonite ores and oxide ores carrying rhodonite, it is doubtful if slag content of manganous oxide as low as 6 per cent and 8 per cent can be produced. The manganese dioxide, on which available oxygen is calculated, is also the base for available manganese. The following table gives analyses of some of the rhodonite ores smelted, the recoveries of alloy and analyses, with slag analyses, taken from operations on the 1800-kw. furnace referred to as the second furnace in this article:

ORE ANALYSES. RHODONITE AND OXIDE ORES

Mn	MnO	MnO_2	SiO_2	Fe_2O_3
41.8	11.5	52.0	24.3	2.20
47.6	16.0	55.0	23.3	2.30
44.1	18.4	47.3	21.9	1.20
46.9	16.1	54.6	15.0	2.10
45.8	14.4	54.8	16.0	1.60
45.9	11.9	58.0	16.4	2.10

Manganese recoveries.............72 per cent to 80 per cent

ALLOY ANALYSES

Mn	Fe	Si	S	P	C
81.9	9.50	0.95	0.034	0.044	7.05
82.5	10.50	1.60	0.020	0.085	4.95
81.4	11.55	1.35	0.005	0.090	5.55
81.3	11.50	1.41	0.004	0.102	5.65
82.0	11.20	1.56	0.002	0.075	4.95
81.7	11.80	0.50	0.003	0.090	5.75

SLAG ANALYSES

MnO	CaO	SiO_2
14.6	41.7	36.8
17.9	42.2	34.7
16.7	42.3	34.7
16.3	41.3	36.0
14.4	42.0	40.2
11.18	44.8	37.2
18.8	34.5	37.2
17.5	39.7	36.6
18.2	37.6	35.7

The manganous oxide content of slags in these operations may have been decreased by increased carbon content on the charge. But as charcoal and coke were the items of greatest expense, it was necessary to conserve these materials. Also running on heavy lime burdens caused carbide accretions and electrode losses by carbon going into solution. As the manganese carbides form a soft disintegrating alloy, it was desired not to go over 6.5 per cent carbon in the alloy.

PROPERLY DESIGNED LARGE FURNACES ARE EFFICIENT

From the foregoing accounts it might be inferred that "large" size furnaces are considered wasteful and inefficient. But the "large" furnace properly designed in each component part can be made equally as efficient as a unit one-half or one-fourth the volume or capacity. By increasing the power input to double or triple is not alone sufficient. Decreasing the area of crucible to electrode area may not bring desired conditions. By a careful study of the relations which essential components bear to each other, the efficient operating unit can be constructed regardless of size of transformers, output and volume, etc. On equally rich burdens and nature and size of reducing agent and ore charge, electrical conditions may be brought to a condition of greatest heat development in the furnace. As the nature of the material in the furnace and the magnitude of its heating paths are the principal factors in producing heat, to bring about the chemical reactions these factors must be properly considered and utilized, so that large units may be built with high efficiency of power input and metal recovery.

In any smelting apparatus the rate of applying the heat is the essential problem. The chemical combinations involved produce both axothermic and endothermic reactions. Gases issuing from the furnace carry away heat units in their sensible heat. Radiation accounts for another decrease of heat in the furnace. By tapping slag and alloy, heat is again drawn from the furnace. In the electric furnace, heat is supplied by the electrical resistance of the charge, and by multiple arcs of contact, at the electrode ends. The furnace must be in proper condition to quickly build up at all times its load for heat generation. The furnace crucible should be so proportioned that after tapping, large volumes of cold charge do not come down and cut off the load for long periods, by cooling the crucible and its contents.

The greater the rate of power input to the furnace the more easily can the operations be controlled. Power input is heat input. Rate of heat input means rate of metal output. Kilowatt-hour consumption is directly balanced against calories and metal output. But only by proper design can power input be properly and efficiently utilized for alloy or metal production and recoveries.

Milwaukee, Wis.

An Apparatus for Determining the Thermal Conductivity of Metals

BY GORDON B. WILKES
Assistant Professor of Industrial Physics, Massachusetts Institute of Technology

THE precise determination of the thermal conductivity of metals by a simple laboratory testing device is becoming of more and more importance in numerous technical and scientific lines. The enormous development of the gas engine in the last few years has brought forward the problem of cooling the cylinder and piston, and the thermal conductivity of the metals composing these parts plays an important part in the efficiency of any cooling system. All of the various types of heat interchangers are dependent primarily on the high thermal conductivity of their walls, which are usually composed of some sort of metal. The conductivity of the pure metals has been known with some precision for a long time, but that of the alloys is still unknown except in a few instances, and the thermal conductivity of an alloy cannot as yet be predicted from its constituents.

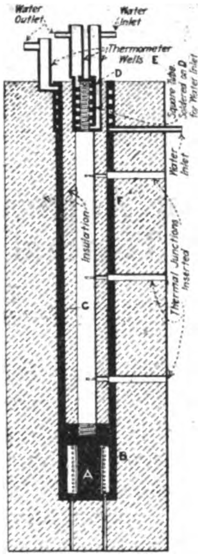
At the suggestion of Prof. Zay Jeffries, director of research, Aluminum Castings Co., the author designed and built the apparatus which is here described, for determining the coefficient of thermal conductivity of metals, especially aluminum alloys.

The apparatus was designed for use in a commercial laboratory and consequently was made as simple as possible, consistent with the results desired. It was required that the specimens be of such shape that they could be easily cast and prepared for testing with a minimum amount of machine work. The temperature range to be covered by the tests was from 20 to 600 deg. C., and the precision required was 2 per cent.

The familiar guard-ring method used so much for determining the thermal conductivity of heat insulators was used as the basis of the design, modified, of course, to meet the conditions of the problem. The tester consisted, essentially, (1) of a heater, (2) a guard-ring, not necessarily of the same material as the specimen, (3) two continuous flow calorimeters, and (4) three thermocouples used in measuring the temperature of different parts of the specimen.

Referring to the sketch of the apparatus, we have the heater *A*, consisting of a coil of suitable resistance wire wound on a brass core, and insulated from it by thin sheets of mica. A suitable rheostat is connected in series with this heater, in order that the temperature may be regulated at will, and an ammeter placed in the line is a great convenience, but not a necessity. This core is screwed into a hollow brass cylinder *B*, as shown in the sketch.

The specimen *C* is a rod, approximately 14 in. long and ¾ in. in diameter, the lower end of which is threaded into the brass cylinder *B* with a standard ¾-in. thread, while the last 2 in. of the upper end is turned down to ½ in. in diameter and cut with a fine thread, approximately 24 threads to the inch. The latter end has also a slot cut across the top, so that a screwdriver may be used for removing the specimen at the end of a test. The calorimeter *D*, which is screwed on this end of the specimen, is formed out of a solid cylinder of brass, drilled and tapped ½ in. diameter, 24 threads to the inch, on top of which a $\frac{3}{16}$-in. square thread is cut, forming the water passage around the specimen. The two ends of this square thread are connected to the two thermometer wells *E*, in which are inserted thermometers used in measuring the temperature of the inlet and outlet water.



SKETCH OF THE APPARATUS

The guard-ring *F* consists of a brass tube, 2¼-in. outside diameter and ¼-in. wall, which is screwed onto the brass cylinder *B*. The other end of the guard-ring has a square thread cut on the outside for a length of 2 in., over which a thin brass sheet is soldered, forming the guard-ring calorimeter. One end of this square thread is connected directly to the inlet water supply, while the other end first passes through a thermometer well, and thence to the waste pipe.

The temperature of the specimen is measured at three points along the rod, by means of small thermocouples inserted through holes drilled in the guard-ring and the specimen. The holes in the specimen should not have a diameter in excess of $\frac{1}{16}$ in., and are spaced 4 in. apart in such a manner that the center hole is equidistant from the calorimeter and the cylinder *B*. The space between the specimen and the guard-ring is filled with a thermal insulator (Fire-felt), in order to prevent convection currents from carrying heat to the calorimeters directly; in like manner the two calorimeters are insulated from each other, so as to eliminate any chance of transfer of heat between them. The entire apparatus is insulated on the outside with about 2 in. of good insulation to prevent any unnecessary heat loss and to secure constant temperature conditions.

The temperatures of the specimen and the guard-ring must be essentially the same where they leave the brass block *B*, both being screwed to the block and in intimate thermal contact with it; also the temperatures at the point where they enter their respective calorimeters must be the same, both being in contact with water at approximately the same temperature. If the specimen and the guard-ring are at the same temperature at their ends, and there is no appreciable heat flow outward in comparison with the flow of heat along the metal, any two points on the specimen and guard-ring, at the same distance from the heater, will be at approximately the same temperature, and consequently there will be no transfer of heat between the specimen and guard-ring. In order to check this statement experimentally, thermocouples were placed on the guard-ring at points corresponding to the thermocouples in the specimen, and the temperatures at any two corresponding points were found to be the same.

If an electric current is allowed to flow through the heating wires, the temperature of the block *B* will be raised, and if a constant stream of water is maintained through the calorimeters, a uniform low temperature will be obtained at the upper end of the specimen and the guard-ring. The temperature of the block *B* will eventually become constant, provided the heating current is kept constant, and we shall have a uniform flow of heat along the specimen and the guard-ring toward the calorimeters. Any quantity of heat that enters the specimen from the block *B* will flow along the specimen without any gain or loss of heat until it reaches the calorimeter, because there is no tendency for heat to flow unless there is a difference in temperature. All of the heat that enters the calorimeter *E* flows from the specimen, because the calorimeter is very nearly at the same temperature as the surrounding air and the guard-ring calorimeter, and in addition is insulated from these.

When thermal equilibrium has been established, which takes about 2 hr., the coefficient of thermal conductivity may be calculated if the following data are known:

A = Cross-sectional area of the specimen in sq.cm.
D = Distance between any two thermocouples in cm.
T_1 = Temperature of the hotter thermocouple in deg. C.
T_2 = Temperature of the colder thermocouple in deg. C.
T_3 = Temperature of the inlet water to "D" in deg. C.
T_4 = Temperature of the outlet water from "D" in deg. C.
W = Weight of water in grams, passing through the calorimeter during one second.

The coefficient of thermal conductivity, *K*, expressed in gram calories per second, per sq.cm., per cm. thickness, per 1 deg. C. temperature difference, may be calculated by the following expression:

$$K = \frac{W\,(T_4 - T_3)\,D}{(T_1 - T_2)\,A}$$

The data taken from a sample of commercially pure aluminum rod may be of help in showing how the values run for an actual observation.

T_1 = 485 deg. C.
T_2 = 120 deg. C.
T_3 = 16.13 deg. C.
T_4 = 23.40 deg. C.
A = 2.86 sq.cm.
D = 20.3 cm.
W = 3.11 g. of water per second.

$$K = \frac{3.11\ (23.40 - 16.13)\ 20.3}{(485 - 120)\ 2.86} = 0.440$$

In order to express *K* in B.t.u. per 24 hr., per sq.ft., per in. thickness, per 1 deg. F. temperature difference, the above value must be multiplied by 69,800.

In regard to the precision of the results, it will be seen readily that any of the factors used in the equation can be determined with much more than the required precision, consequently only the constant errors due to the design of the apparatus will affect the result so as to make the value of *K* in error more than 2 per cent.

The question of direct conduction to the calorimeter *D* by the insulation between the specimen and the guard-ring is negligible because the relative conductivity of the insulation and the specimen is about 1 to 2000, and their respective areas are approximately 7 to 1. The total amount of heat conducted by the insulation is only 7/2000 of the heat conducted by the specimen, and of course no large part of this heat would go into the calorimeter *D*. The question of a transfer of heat between the specimen and the guard-ring depends upon the nature of the specimen and the guard-ring. If they are both of the same material, there will be no transfer of heat, because there will be no difference of temperature between the adjacent parts of the two. If they are not of the same material, their similarity of temperature and the transfer of heat between them will depend on possible differences in the temperature coefficients of their thermal conductivity, i.e., their change of thermal conductivity with temperature change, and is independent of their relative conductivities. Even at the worst, this loss is certainly small. The average area of the insulation, transmitting heat between the specimen and the guard-ring, is approximately 110 sq.cm., and assuming the relative conductivities stated above, the loss of heat to the guard-ring, with the specimen averaging 20 deg. C. higher temperature, will be only 1 per cent of the heat transmitted by the specimen. The temperature coefficients would necessarily have to be very different to produce an average temperature difference of 20 deg. C.

On account of the small temperature difference between the two calorimeters, which are also insulated from each other, there will be a negligible transfer of heat between them. If the thermometer wells are designed like those in the sketch, it has been clearly shown by a large number of tests that the thermometers will truly record the temperature difference between the entering and exit water and there will be no chance of any error from this source greater than ½ or 1 per cent. I believe that all of the larger sources of error have been taken into account and that they cannot affect the result by amounts as large as 2 per cent.

In conclusion, it might be of interest to state that an apparatus of this sort has been in use for over six months in a commercial laboratory and has given satisfactory service. I also wish to express my thanks to Prof. C. L. Norton of the Massachusetts Institute of Technology for his help in the design and construction of this apparatus.

Rogers Laboratory of Physics,
Mass. Institute of Technology,
Cambridge, Mass.

Mine Output of the Central States, 1918

The 1918 production of non-ferrous metals from the mines of the Central States was 73,643,398 short tons less than for 1917, in value $30,861,000. The decrease, principally due to the curtailment of production of the Michigan copper mines, was for copper 28,703,337 lb. and for silver 192,746 oz.

The output of Missouri zinc decreased 76,926 short tons, while the Oklahoma production increased 75,566, the two States changing places as the largest producer.

Producer Gas Costs

The following table of producer gas costs published by the Steere Engineering Co., Detroit, includes fuel, power, repairs and maintenance, labor and supervision, interest and depreciation; in fact, every item of cost except the interest and taxes on the land occupied.

Producer Gas Costs per 1000 Cu.Ft. for Coal Costs Given			Costs at Which Other Fuels Must Be Bought to Obtain the Same Number of B.t.u. as When Buying Producer Gas With Coal at the Price Given							
			Natural Gas per 1000 Cu.Ft.		Fuel Oil per Gallon		Coal Gas or Carburetted Water Gas per 1000 Cu.Ft.		Blue Gas per 1000 Cu.Ft.	
Cost of One Ton of Coal at Plant	Hot Raw Producer Gas at Offtake	Clean Cold Producer Gas	Hot Raw Gas	Clean Cold Gas	Hot Raw Gas	Clean Cold Gas	Hot Raw Gas	Clean Cold Gas	Hot Raw Gas	Clean Cold Gas
$2.00	3.13c.	4.15c.	23.7c.	31.5c.	2.91c.	3.86c.	12.6c.	16.72c.	6.45c.	8.59c
2.50	3.55	4.57	26.9	34.67	3.3	4.25	14.3	18.40	7.34	9.45
3.00	3.96	4.98	30.1	37.84	3.69	4.64	16.6	20.09	8.20	10.32
3.50	4.38	5.40	33.3	41.01	4.08	5.03	17.65	21.77	9.07	11.18
4.00	4.79	5.82	36.3	44.18	4.46	5.42	19.3	23.45	9.92	12.05
4.50	5.21	6.24	39.5	47.35	4.85	5.81	21.0	25.13	10.78	12.91
5.00	5.63	6.66	42.7	50.52	5.24	6.20	22.7	26.82	11.65	13.78
5.50	6.05	7.08	45.9	53.69	5.63	6.59	24.35	28.50	12.5	14.64
6.00	6.46	7.49	49.1	56.85	6.01	6.97	26.0	30.18	13.36	15.50

HEATING VALUES USED

Producer gas	145 B.t.u. per cu.ft.
Natural gas	1,100 B.t.u. per cu.ft.
Fuel oil	135,000 B.t.u. per gallon
Coal gas or carburetted water gas	585 B.t.u. per cu.ft.
Blue gas	300 B.t.u. per cu.ft.

These costs are based on the plant operating with a 100 per cent load factor, that is, operating at rated capacity 24 hours per day, 365 days per year. Comparatively few plants have a 100 per cent load factor, and therefore it is necessary to take this very important point into consideration when estimating the cost of gas.

The cost of producer gas, with a reasonable degree of accuracy, may be estimated for any load factor by applying the formula:

$$C = T + \left[\left(\frac{R \times 400}{A \times B}\right) - 2.38\right]$$

Where

C = Cost of producer gas per thousand cu.ft. under conditions specified

A = Number of feet of gas used per day

B = Days per week plant is in operation

T = Cost figures shown in table at 100 per cent load factor

R = Rated hourly capacity of plant in cubic feet

It also must be kept in mind that furnace efficiencies have a very great bearing on the cost of the finished product. Without regeneration or recuperation producer gas cannot be used as efficiently as the more concentrated fuels. The expense of the distribution system and the furnaces also have an important bearing on the total cost of doing the work.

MINE OUTPUT OF THE CENTRAL STATES, 1918 (a)
(1917 Output Shown for Comparison)

State	Ore Treated (Short Tons) 1917	Ore Treated (Short Tons) 1918	Silver (Fine Oz.) 1917	Silver (Fine Oz.) 1918	Copper (Lb.) 1917	Copper (Lb.) 1918	Lead (Short Tons) 1917	Lead (Short Tons) 1918	Zinc (Short Tons) 1917	Zinc (Short Tons) 1918	Total Value 1917	Total Value 1918
Arkansas	203,600	37,000	......	......	....	....	382	120	6,691	951	$1,430,668	$110,122
Illinois	237,340	b 280,900	7,186	8,171	....	....	1,439	2,273	4,267	3,792	1,123,897	1,021,081
Kansas	903,400	1,025,400	......	......	....	....	3,025	7,252	20,249	30,197	4,651,096	6,525,638
Kentucky	c	c	......	......	....	....	123	185	751	315	174,360	83,600
Michigan	12,400,723	11,321,365	688,551	509,467	255,710,128	226,794,139	......	......	......	......	70,376,231	56,527,619
Missouri	17,024,800	9,146,800	61,586	46,939	365,013	577,665	234,156	194,175	132,918	55,992	67,540,500	37,953,016
Oklahoma	3,523,200	5,754,700	......	......	....	....	26,358	56,097	85,835	161,401	22,043,916	37,340,756
Wisconsin	3,014,800	2,377,300	......	......	....	....	4,139	4,533	59,742	50,014	12,899,276	9,746,234
Total	37,307,863	29,943,465	757,323	564,577	256,075,141	227,371,804	269,622	264,635	310,453	302,662	$180,239,944	$149,388,066

(a) The average market prices used by the U. S. Geological Survey in figuring values of production of metals for the calendar year 1918 are: Silver (average price as given by Bureau of the Mint), $1 per fine oz.; copper (sales price all marketable grades), $0.247 per lb.; lead (sales price all grades), $0.071 per lb; zinc (spelter) (sales price, all grades), $0.091 per lb.

(b) Includes only ore from Northern Illinois.

(c) Tonnage not available.

The Flash and Burning Points of Gasoline-Kerosene Mixtures*

Effect of Gasoline Content on the Flash and Burning Points of Kerosene — Foster Closed Cup and Cleveland Type Open Cup Methods Compared — Flash and Burning Points of Kerosene Mixed With "Low-Test" Gasoline, "High-Test" Gasoline and "Petroleum Ether"

By JAMES T. ROBSON and JAMES R. WITHROW

THE results indicated by the investigations covered in this paper and by the literature on the subject which is reviewed herein are:

The profound effect upon the flash and burning point of kerosene and therefore the fire and explosion hazard of the smallest percentages of gasoline or similar volatile petroleum fractions added to the kerosene.

Gasoline cannot safely be permitted in kerosene.

The early records of the influence of light petroleum distillates upon burning oils were based upon fractions radically different in properties from similarly named products of modern refining.

The main original need for State flash point laws has ceased. Nevertheless, public safety still requires their enforcement.

The Foster closed cup flash determination permits the presence of much lighter petroleum distillates than the Cleveland open cup method.

The gasoline and other light petroleum fractions are found to be miscible instantaneously with kerosene if intimately mixed. It is concluded that stratification in large tanks is merely due to insufficient mixing or lack of time for diffusion.

While ordinary kerosene of commerce extinguishes a burning match, the addition of gasoline to the extent of 1 per cent may give a flash; 3 to 5 per cent gives violent flashing, and 7½ per cent inflames at once. Any of these would have given explosions if confined.

The relation is established between flash and burning point and percentage of volatile petroleum fractions admixed with kerosene. Working conditions are given minutely, to establish the comparative dependability of the final values for future cases of comparison. Distillation and gravity characteristics of the fractions used are recorded.

Because of our inability to obtain material assistance from the literature on the influence of the addition of gasoline to kerosene with respect to the explosion hazard after the kerosene was marketed, it seemed desirable to publish portions of the work made necessary by this scanty literature.

FATAL RESULTS FROM GASOLINE-CONTAMINATED KEROSENE

One or several deaths appear to have resulted from explosions in the use of kerosene admitted to have been marketed in Ohio by an oil refiner. It is also admitted that an employee of the refiner inadvertently pumped gasoline into a kerosene storage tank and also that kerosene was subsequently sold from this tank batch. It was claimed by the plaintiffs that the kerosene causing fatal explosions could be directly traced to this contaminated kerosene storage. It is claimed by employees of the refiner that a gallon sample was drawn off of the contaminated kerosene tank and its flashing properties tested and found "safe."

It would probably have to be admitted that a draw-off of one gallon would not clear the uncontaminated kerosene from the draw-off line, and as a result the "safe" flash test would not reveal the true character of the tank contents. In this same connection also it was claimed by the plaintiff that stratification probably existed in the tank anyway and therefore a sample withdrawn from the bottom of the tank would inevitably test "safe" in flash point. It was also claimed that dispensing from said tank would soon reach a highly dangerous zone because richer in gasoline.

No exact evidence was available as to the amount of kerosene originally in the tank or the amount of gasoline pumped into it or the amount of the mixture resulting. It would probably have to be admitted, however, that there was more than 2 per cent gasoline as a minimum admixed with the kerosene or any lot sold therefrom if admixture were complete. No actual sample of the mixture appears to have been preserved by either side. The samples causing the explosions were destroyed thereby.

In 1861 Allen (*Smithsonian Reports*, 1861, p. 380) reported on the "Explosibility of Coal Oil," an investigation instigated by the Rhode Island Mutual Fire Insurance Co. to study various "coal oils." Both petroleum and coal-tar products were included under "coal oil." That gasoline was then a drug on the market was pointed out, as was the artificial production of kerosene with a kerosene gravity by judicious mixtures of higher and lower fractions than the kerosene fraction proper.

Allen made flash point determinations in open cups floating in water at various temperatures. This seems to us a cumbersome manipulation as compared with our simple direct heated or water-bath heated devices. He did not know the amount of "adulteration," however.

K. V. Weise in Wagner's "Chemische Technologie," 1871, p. 865, with the open cup method found:

	Sp.Gr.	Flash Point, Deg.	Burning Point, Deg.
Petroleum	0.805	30	43
Petroleum + ½ per cent naphtha	0.710	25	40
Petroleum + 1 per cent naphtha	0.710	22	32
Petroleum + 3 per cent naphtha	0.710	20	29

This work is by far the most complete along this line in the literature. The oils used, however, are quite different from those with which we are concerned. The closest to our conditions are these:

	Flash Point, Deg.	Burning Point, Deg.
Petroleum, 0.806	55	70
Petroleum + 2 per cent naphtha	45	60
Petroleum + 4 per cent naphtha	24	55
Petroleum + 10 per cent naphtha	20	32

There was no closed cup work. The author states that for the determination of the naphtha content, neither the flash point method nor fractional distillation is satisfactory.

In 1887 Crew ("Treatise on Petroleum," 1887, Philadelphia, Henry C. Baird & Co., p. 395) pointed out adulteration of kerosene with dangerous low-boiling fractions and presented a simple "saucer" test to show whether or not a given oil was dangerous for use in lamps.

---

*Read at the meeting of the American Institute of Chemical Engineers, Cambridge, Mass., June 20, 1919.

Crew quotes experiments of Dr. C. B. White of New Orleans resulting as follows:

	Flash Point, Deg. F.	Burning Point, Deg. F.
Oil alone	118	135
Oil with 1 per cent bensine—65 deg. B	112	129
Oil with 3 per cent bensine—65 deg. B	103	123
Oil with 5 per cent benzine—65 deg. B	96	116
Oil with 10 per cent bensine—65 deg. B	83	102
Oil with 1 per cent bensine—72 deg. B	107	133
Oil with 5 per cent benzine—72 deg. B	70	105

Allen's "Commercial Organic Analysis," 4th ed., Blakiston, Philadelphia, 1914, p. 120, states that Dr. B. W. White, using the "open test," with oil which originally flashes at 113 deg. F. found that

1 per cent naphtha reduced flash point to 103 deg. F.
2 per cent naphtha reduced flash point to 92 deg. F.
5 per cent naphtha reduced flash point to 83 deg. F.
10 per cent naphtha reduced flash point to 59 deg. F.
20 per cent naphtha reduced flash point to 40 deg. F.

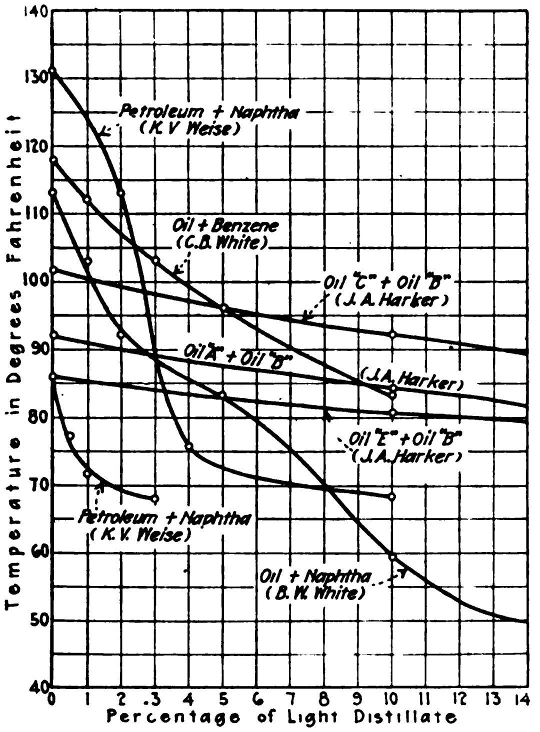


FIG. 1. OPEN CUP FLASH POINTS—EARLY WORKERS

No further information is given. It is not evident whether this is the same Dr. White referred to by Crew.

These results correspond only approximately with ours. They are upon the older type of low-flash kerosene and with uncertain procedure. They are interesting, however, as tending to show the influence of definite admixture of an oil of known flash point. No modern case has been found by us where there is a clear correlation between definite admixture of characterized products and the flash and burning tests with prescription of conditions of test.

Steingräber (*Oesterr. Chem. Zeit.*, 1900, pp. 589-99; *J. Soc. Chem. Ind.*, 1901, p. 352) tried to determine how far the properties of "illuminating" fractions of oil were affected by benzene mixtures. He used 21 deg. C. flash oil as standard and added various amounts of benzene and higher fractions. His results showed that only benzenes boiling below 100 deg. C. have strong influence on flash. Additions of higher boiling benzenes have little effect; 21 deg. C. (or 70 deg. F.) is too low as a flash oil to be taken as a standard to determine effect of benzene on flash. With 110 to 120 deg. F. flash oils as standards, effect of higher boiling benzenes are somewhat different than found by Steingräber.

H. C. Sherman, T. T. Gray and H. A. Hammerschlag (*J. Ind. Eng. Chem.*, vol. 1, 1909, p. 13) compared the calculated and determined viscosities and flashing and burning points of oil mixtures. This work shows that the calculated flash point is not the same as the actual. The work was not on kerosene, however.

J. A. Harker and W. F. Higgins in "The Methods and Apparatus Used in Petroleum Testing" (*Nat. Phys. Lab., Collected Researches*, vol. 8, 1912, p. 38) give a method for calculating flash points of different mixtures of oils. No method is given of identifying their oils. Intervals (10 per cent) of mixture used are so large that it is not justifiable to determine flash point for any intervening mixture, say 92 or 97 per cent.

Harker's work intends to give a method of determining the flash point when the composition is known but omits identification of his oil.

Our work will give approximately the composition of the mixture from a determination of the flash point and interpreting on the basis of the distillation curves which identify our oils.

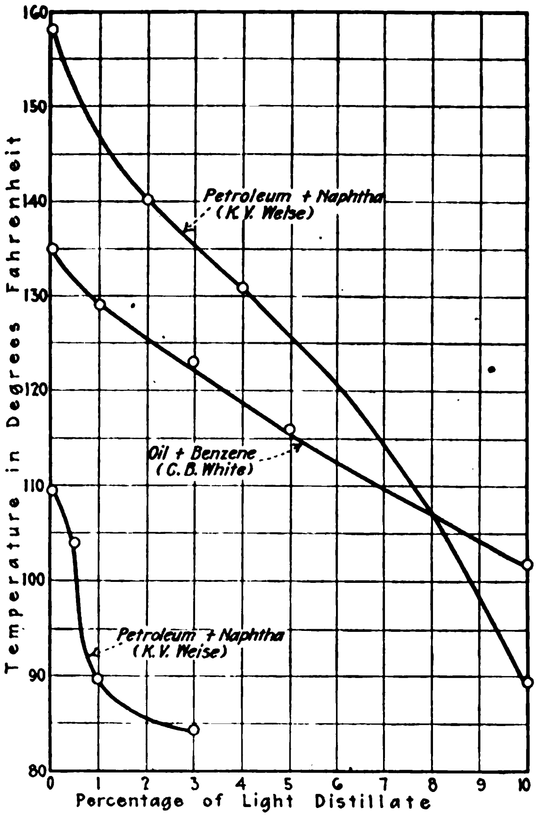


FIG. 2. BURNING POINTS—EARLY WORKERS

Curves representing the values recorded by these earlier workers appear in Figs. 1 and 2.

FACTORS INFLUENCING FIRE HAZARDS OF GASOLINE AND KEROSENE

Strictly speaking, the flash point by itself does not determine the fire hazard of any substance. The factors which also influence fire hazard are:

(*a*) Volatility.
(*b*) Boiling point.
(*c*) Vapor pressure.
(*d*) Vapor density.

(*e*) Diffusibility and tendency of vapors to travel.
(*f*) Explosive limits in air.
(*g*) Tendency to chemical change.
(*h*) Quantity of heat liberated per unit of volume.
(*i*) Temperature of flame.
(*j*) Corrosive action.
(*k*) Behavior toward water before and after ignition.
(*l*) Tendency of substance to leak.
(*m*) Prolonged heating effect.

Kerosene in a tropical climate gives lower "flash" than the same oil in a temperate climate. The trouble is due primarily to accumulation of vapors caused by continued high temperature and secondarily in discharging or moving oil by vapors disengaged on pouring and shaking.

It is well known that cold kerosene of good legal quality will not take fire when light is applied, nor will the supernatant vapor inflame. The "burning test," fire test, i.e., temperature at which oil permanently inflames, is sometimes taken as a test of burning or firing value, but is not strictly reliable since oils spilled in a thin flow will ignite instantly on approach of a flame, even when the burning point is considerably higher than the flash point. It is also well known that with refined burning oil no inflammable or explosive mixture could be formed, even in the absence of ventilation, up to 70 deg. F. At temperatures much above 80 deg. F. and with no ventilation, such an atmosphere could be produced with most oil.

EARLY FLASH POINT LAWS AND PRESENT REVERSED STATUS OF GASOLINE AND KEROSENE PRODUCTION

It would have to be admitted that the presence of lighter or gasoline fractions in kerosene has long ceased to be profitable to the refiner. Hence as an evil it has needed little attention in recent times.

If commercial gasoline of any gravity is accidentally pumped into or by faulty valving or otherwise gets into a kerosene fraction storage, its detection is quite simple by the flash test. Simple considerations indicate, however, that this can be no quantitative indication of the amount of such contamination except the "flash point" determination be calibrated with reference to this particular kind of occurrence. Individual oil companies or chemists doubtless have felt the need for such a correlation and perhaps have made it. Few of these results have gotten into the literature. From year to year we have had cases arise which raised the question: "How much gasolene does this particular contamination represent?" Recently the question arose again under the circumstances already mentioned, which made a partial answer to the general question necessary, and the results obtained with our set of conditions are here recorded.

In the earlier period of petroleum refining, kerosene or "burning oil" was the valuable light product or early distillate. At that time it was a temptation to producers to put into kerosene all the traffic would stand of lower boiling (gasoline) fractions, together with the maximum of higher boiling fractions next above the burning oil, to balance the lighter gravity of the gasoline fraction. This virtually amounted to a physical synthesis of kerosene by mixing with each other the next lower and higher fractions. This was a perfectly justifiable procedure, if a safe one, to meet commercial demands in the days that developed "cracking" for burning oil formation. "Gravity," however, was not the sole consideration. There was a safety limit which was important because the consumers in the homes of the land might be made the victims of unnecessary fire hazard, through refiners' carelessness or unscrupulousness in this connection. Many tragedies resulted and legislation put a curb to syntheses of this kind by setting legal limits in a modified practical safety test in the flash point laws.

Of the law requirements (Gill's "Oil Analysis," 3rd ed., J. B. Lippincott, Philadelphia, p. 131; Stillman's "Engineering Chemistry," Chemical Publishing Co., Easton, Pa., 1916, p. 450) in 31 States, 19 fix a minimum flash point of 100 to 125 deg. F. and 12 States make a minimum "burning point" instead of flash point requirement. The burning point runs from 100 to 150 deg. F. in the States making the requirements. Four States set both a minimum flash and burning test and 16 no burning point test at all. These State laws specified in all except 8 cases the form of test, whether in "open" or "closed" apparatus. In only four cases was "open" testing permitted. In all other cases a closed tester was prescribed, thus closely simulating lamp or confined conditions, and the specific instrument was named such as the Tagliabue or Foster. From the results herein reported it will be seen that the closed cup of the Foster type may permit the presence of much more gasoline in a burning oil than does the open cup test for the same flash point.

GASOLINE AT THAT TIME A DRUG ON THE MARKET

In that early period of the petroleum refining industry, gasoline was a drug on the market. All the art of sales was directed to the creation of an outlet. The public had to be protected, therefore, against unscrupulous addition of gasoline to kerosene to increase production volume of the latter. Now the situation is reversed. The advent of the hydrocarbon or internal combustion engine about 1898 has created ever increasing demands for the gasoline fraction, so that the kerosene demand by comparison stands still. Now, as a result, the refiner puts everything into gasoline that the traffic will stand. This is as it should be, if understood. Consequently, the cheaper kerosene fraction is stripped as lean as possible of volatiles to raise the volume of the gasoline fraction. This puts so much of the front end of kerosene into gasoline that, of course, the gasoline is made heavier in gravity as is the kerosene. This greatly raises the flash and burning point of the kerosene, because the more volatile portion was cut off to add to gasoline. This is so effectively done in wide awake refineries that the State flash point laws are almost a dead letter. They, nevertheless, are necessary, because there are still a few poorly equipped or carelessly operated refineries. Occasionally errors or accidental contamination of kerosene storage will occur and the plant manager refuses to re-strip the mixture to save expense and instead works it off on the trade. We seem to meet occasionally just this situation in Ohio State oil inspection, and the protection to the public in these cases justifies the continuance of this State activity. In addition, there are the mistakes of delivery and petty storage-filling between wholesaler, retailer and eventual delivery to consumer. These, while not common, are much more common than refiners' mistakes, but are depressed in number by vigorous legal inspection and law enforcement, particularly in rural sections.

When the State Oil Inspector's office picks up offenders under the Ohio law it at times can trace a somewhat connected series of infractions indicating a bad lot of kerosene and at times traceable to the refinery. In referring such matters to this laboratory the question is sometimes asked about the extent of gasoline contamination. It is not necessary to cite cases except to state that confirmation of the field inspector's test have at times been so good as to have the product pop off on lighting the paper in the Foster closed cup (the legal test instrument in Ohio). The taper is lighted customarily at 90 deg. F. and the Ohio minimum flash point for kerosene is 120 deg. F. Such a product is highly dangerous as a kerosene.

For this portion of the public welfare and safety, the State oil inspection laws are still an important factor. Careful, honest dealers and refiners have no quarrel with these laws.

THE FLASH AND BURNING POINT TESTS

There are some factors which must be clearly understood when dealing with flash point determination. The substances kerosene and gasoline themselves are not chemical compounds, but mixtures of hydrocarbons. "Kerosene" is a trade name. It is also called "coal oil" and "illuminating oil." Industrially it is understood to be a mixture of hydrocarbons "entirely" free from gasoline and naphtha on the one hand and from heavy hydrocarbons belonging to gas oil and lubricating oil on the other. This (kerosene) mixture is supposed to be only moderately soluble in alcohol but miscible in all proportions with ether, chloroform, benzene, petroleum spirit, volatile and fixed oils except castor oil.

Gasoline is a mixture of the lower series of hydrocarbons. It is lower in boiling point and lighter in gravity than kerosene. It includes all of them that are not "wild" or which will stay in a reasonably corked container and running as heavy in gravity as motor vehicles can start and navigate under. It usually includes all the old materials called variously petroleum spirit, petrol, benzine, etc. Formerly, that which distilled below 150 deg. C. was "spirit" or gasoline; 150 to 270 deg. C. was kerosene, and 270 deg. C. up was heavy oils. This was only conventional. Refineries ran largely on gravity. The consumer became acquainted with a specific gravity test. It was easy to perform and the refiner cut his fractions at various gravities in order to have his cuts average some other gravity required in the trade.

The flash point is the lowest temperature to which the oil need be heated under a fixed set of conditions to give off vapors in sufficient quantity when mixed with air to explode upon the approach of a flame.

The burning point or "fire test" is the lowest temperature at which oil will give off sufficient vapors to burn continuously when ignited.

The flash point and burning point tests are arbitrary. They are not measures of rigorous constants, yet they are capable of much refinement. They are accurate determinations of the practical effects of complex factors. For these reasons the values as determined are susceptible to influence from many sources, among which may be mentioned:

1. Barometric pressure.
2. Nature of bath as a source of heat.
3. Design of oil cup.
4. Features of thermometer.
5. Rate of heating.
6. Effect of prolonged heating or cooling.
7. Manipulation of test (manner flame is applied for flashing, etc.)
8. Room temperature and conditions.
9. Initial temperature of oil being tested.
10. Influence of water presence.
11. Personality of operator.

Even the determination of the flash point of a pure hydrocarbon (from the mixture whose vapor pressure effect is really the matter at issue) would be influenced by most of these factors.

The aim was a practical test, and experience has forced precautions and developed refinements. Burrell and Boyd (U. S. Bureau of Mines Tech. Paper 117) have pointed out the relation between vapor pressure and explosiveness of air gasoline mixtures as related to sewer atmosphere. No one appears to have correlated vapor pressures and explosion and ignition studies of vapor-air mixtures in connection with flash point determinations. The machines in use are accurate enough for short-cut results and are certainly practical in that they simulate burning lamp conditions.

CHARACTER OF THE MISCIBILITY OF GASOLINE-KEROSENE FRACTIONS

Among the questions raised in connection with the litigation referred to were (1) the nature or degree of miscibility of gasoline and kerosene fractions in each other, and (2) the influence upon the flashing properties of a kerosene in the event of miscibility proceeding at a practically instantaneous rate.

It is well known that petroleum fractions are miscible in one another. It cannot, therefore, be assumed that this has no limit in the case of any two restricted fractions in the absence of whole series of hydrocarbons of the original petroleum. Experiment upon various "gasolines" and a sample of kerosene, using every precaution to prevent mechanical mixing, practically always resulted, in the laboratory, in a product with the same flash and burning point as a thoroughly mixed sample. This appeared to be independent of the time of contact, position of admission to the kerosene, depth of kerosene layer (up to 1 ft.), portion of layer from which test sample was withdrawn, and the relative proportions used. This completely answers the ultimate degree of miscibility of the gasoline and kerosene fractions available for our experiments. The results also appear to answer the question of the nature of miscibility, i.e., it appears to be instantaneous. As these were laboratory experiments, they cannot be offered as conclusive, for they are subject to the criticism that an apparently instantaneous time factor in the laboratory may be quite a different matter in the plant where great volumes and depths of tank are factors modifying the situation. Also it is well known to refiners of light-boiling oils such as petroleum and coal-tar hydrocarbons that mixing or blending in tanks even as small as 10 x 12 ft. does not proceed automatically upon mere addition, but air agitation is necessary to insure completeness of mixing. We possess no exact knowledge on this subject and carried out no experiments in view of the trouble and expense attached thereto and because of the existence of definite experience that miscibility has a real time factor in large-scale operations. As an illustration, petroleum distillate tanks have been known to test 45 deg. B. at the bottom, 47 deg. at the middle and 49 deg. at the top. Again, pumping a light gravity oil into a 250-bbl. tank containing heavier oil, inlet at bottom, showed, when

240 bbl. were in the tank, 58 deg. B. at the bottom, 61 deg. at the middle and 68 deg. at the top; quantities used not known.

THE INFLAMMABILITY OF GASOLINE-KEROSENE MIXTURES

The following results indicate the effect upon the flash and burning behavior of kerosene used by admixtures of gasoline at ordinary temperature. These experiments were carried out in an ordinary granite ware cup, using 100 cc. of oil each time. In these experiments, "low-test" gasoline was used. The kerosene was measured in a 100 cc. graduate and the gasoline up through 3 per cent was measured in pipettes. From 5 per cent on, the gasoline was measured in the cylinder. With 100 per cent kerosene a lighted match when applied quickly or very slowly was extinguished. With 99 per cent kerosene and 1 per cent gasoline the match flashed when added but was extinguished when immersed in oil. With 3 per cent gasoline and 97 per cent kerosene, there was a flash more noticeable than with the 2 per cent mixture, but the match was also extinguished when immersed in the oil. With 5 per cent gasoline and 95 per cent kerosene the oil flashed violently, but did not burn. With 7½ per cent gasoline and 92½ per cent kerosene the oil flashed with a puff and readily burned when the lighted match *touched* it. With 12½ per cent gasoline and 87½ per cent kerosene the oil flashed with a loud puff and readily burned when the lighted match *approached* it.

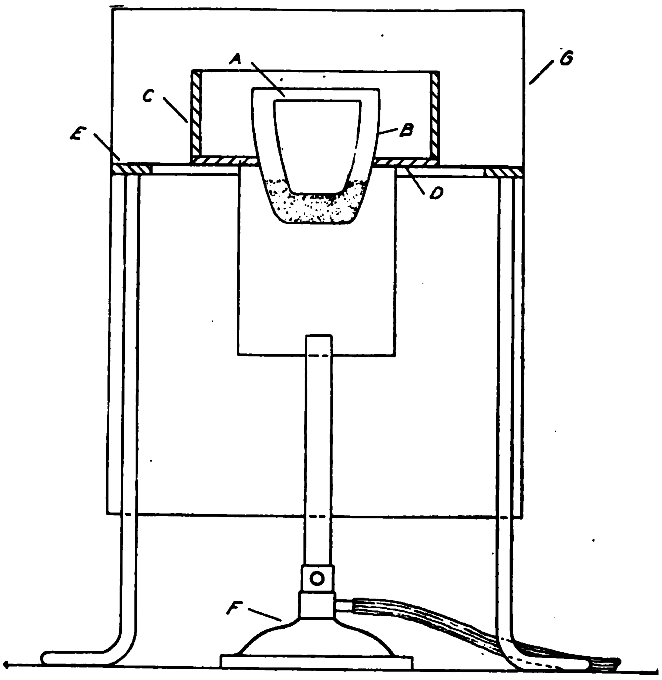


FIG. 3. OPEN CUP OIL TESTER

FLASH AND BURNING POINTS OF KEROSENE-GASOLINE MIXTURES

Since so little is said in the literature about the effects of highly volatile petroleum fractions upon the flash and burning point constants of ordinary kerosene, we have determined the influence upon them in the case of a kerosene mixed with "low-test" gasoline, "high-test" gasoline and "petroleum ether." Both the open and closed cup methods were used for flash point determinations.

The open cup test depends not only upon the skill of the operator but also the condition of the atmosphere, and is affected by the slightest current of air. It is a reliable test, however, for such cases where an oil will be heated in open vessels to determine to what degree it can safely be heated without ignition by flame. With such a case the open test is an actual imitation of the real conditions and therefore fully warranted.

The flash point of kerosene should be high enough so that it will insure safety when the kerosene is burned in a lamp. Danger from a petroleum lamp can occur if the flame flashes back into the petroleum reservoir by accident or carelessness and ignites the vapors which had accumulated in the closed basin. (*Proc. Am. Soc. Testing Materials,* vol. 10, p. 464, 1910.)

The Foster cup method is the standard method for determining the flash point of kerosene prescribed by the law in Ohio, which states that kerosene shall not flash below 120 deg. F. by this method. (Allen's "Commercial Organic Analysis," 3d ed., p. 127.)

METHOD OF USING OPEN CUP PROCEDURE

For determining the open cup flash and burning points an apparatus similar to the Cleveland open cup was used, with the addition of a casing to more efficiently prevent drafts of air. A sketch of this apparatus is shown in Fig. 3. It consisted of a 40 cc. nickel crucible *A*, whose upper surface measured about 4 cm. in diameter. This was placed inside a large 120 cc. nickel crucible *B*, which contained sand to a depth of about 2 cm. This sand bath was then supported in the flame guard *C* by means of the asbestos board *D*, which had a hole cut in its center to admit *B* as shown. The flame protector was supported on the tripod stand *E*. Heat was supplied by the bunsen burner *F* as shown. The whole apparatus was protected from air current by the casing of thin sheet copper *G*. A thermometer was held suspended in the oil by means of a burette clamp on a ring stand. An ordinary mouth blow pipe connected to the gas cock by rubber tubing was used as a tip for the flame to be passed over the oil.

After thoroughly shaking the oil sample, the small crucible was filled to within ½ cm. of the brim. This required 32 cc. The thermometer was then lowered by sliding the burette clamp on the ring stand. The thermometer was held at such a height by the clamp that when the clamp was lowered to the top of the copper shield the bulb was totally immersed in the center of the oil to the same depth each time. Heat was then applied by means of the bunsen burner, so that the temperature rose at the rate of 5 deg C. per min. The test torch was then lighted and the flame made ½ cm. in length. As the flash point was approached, for every degree rise in temperature the flame was passed slowly over the cup horizontally about 1 cm. above the surface of the oil and near the thermometer.

After obtaining the flash point, the test flame was still passed over the oil in a similar manner until the oil permanently ignited. The thermometer was then quickly raised from the oil and the flame in the cup extinguished by excluding the air by means of a solid piece of asbestos board placed over the cup.

All open cup temperatures were read on a 400 deg. C. thermometer. The calibration of this thermometer was checked up by comparing its two fixed points 0 deg. and 100 deg. C. with a standard thermometer. To fix the zero point, the thermometer was surrounded by melting ice and the reading compared with that of the standard thermometer under the same conditions.

The 100-deg. point was then determined by placing the bulb of the thermometer used in the neck of an Erlenmeyer flask containing boiling water so that it was entirely surrounded by steam and the reading on the thermometer was noted in comparison with that of the standard thermometer under like conditions. The barometer reading was also taken and corrections applied. The uniformity of the bore was checked up by detaching a thread of mercury and measuring its length throughout different portions of the stem between 0 deg. and 300 deg. Required corrections were applied throughout all of the work.

For each succeeding test the warm sand from the test preceding was emptied from the cup and fresh sand put in, so that all tests were made under exactly the same conditions. The cup was then cooled by immersion in cold water and thoroughly dried.

In testing mixtures where the flash point was below room temperature, the sand was omitted from the bath, and cracked ice, or ice plus calcium chloride, when necessary, was substituted. Cases where this was required are marked on the table by an asterisk (*).

METHOD OF USING CLOSED CUP PROCEDURE

A standard Foster cup apparatus was used. Its thermometer was checked against U. S. Bureau of Standards thermometer No. 4576. The method of procedure in determining the flash point by the Foster cup was as described in Stillman's "Engineering Chemistry," pp. 448-449. This was as follows: The thermometer with its mounting was removed from the oil cup. The oil cup containing the flashing taper was removed and the open water bath half filled with water. The flashing taper was then removed from the cup and, after thoroughly shaking the oil in its container, it was carefully poured into the cup at the place of the flashing taper wick holder until it just reached the gage mark at the thermometer hole. The cup was then tipped so that the oil flowed away from the gage, and was then gradually restored to the horizontal position. If the surface again adhered to the mark, it was all right; in case it did not, a little more oil was added. The flashing taper was then adjusted to give a flame ½ in. in height. The oil cup was now set in the water bath, the flashing taper returned to its place, the conical thimble inverted around it and the thermometer returned to its place upon the cup, care being taken that the latter was pushed down upon the cup as far as possible. The lamp beneath was half filled with alcohol, lighted, and placed beneath the water bath. The wick was so adjusted that the temperature of the oil was raised at the rate of 2 deg. F. per min. When the thermometer read 90 deg. the flashing taper was lighted and closely observed. In tests where the flash point was 90 deg. or lower, the flashing taper was placed in the cup before applying heat from below. In several instances, as previously mentioned in the open cup method, the mixtures flashed below room temperature. In these cases cracked ice was placed in the water bath and the test repeated. These cases are shown by an asterisk (*) in the tables.

A rather peculiar phenomenon took place in the closed cup flash test. When the oil was previously cooled by ice, it flashed some 5 or 6 deg. higher than when not previously cooled. Thus, in the case of the 7½ per cent mixture of high-test gasoline and kerosene when ice was not used in the bath it flashed at 75 deg. F. (as soon as the pilot was lighted). However, when previously cooled by ice, the mixture had to be heated to 84 deg. F. before flashing, the pilot burning constantly. This may be due to the design of the cup. The flashing taper when in place forms a draft so that when lighted while the oil was below 75 deg. the volatile gases liberated would pass out through the opening and escape, whereas when no light was present the draft was not so great and consequently the concentration of highly volatile vapors in the cup would be greater, so that when a flame was admitted at 75 deg. the concentration of the gases was enough to extinguish it.

All flash points in both open and closed cup have been corrected for normal barometric pressure, 760 mm., by Table I (U. S. Bureau of Mines Technical Paper No. 49). In order to show to what extent the barometric pressure affects the flash point, the solid curves have been drawn which represent the flash points when corrected for barometric pressure and the dotted curves which do not include barometric pressure correction.

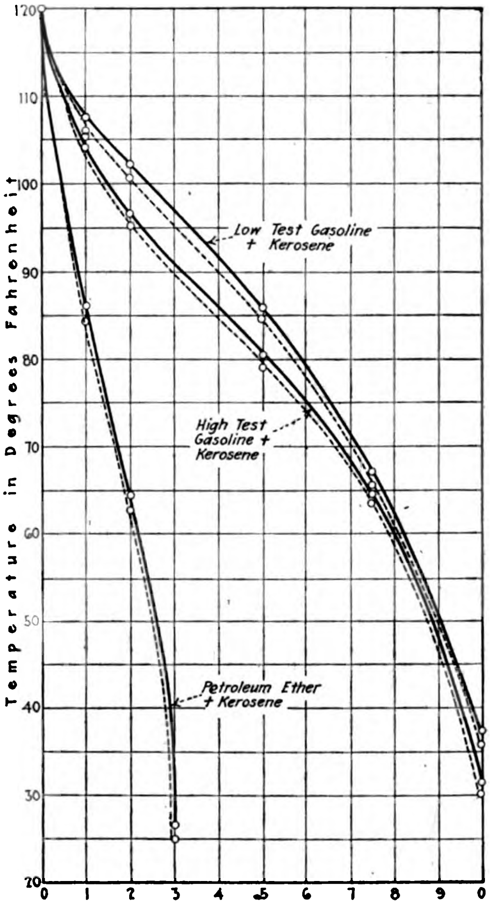


FIG. 4. FLASH POINTS OF GASOLINE-KEROSENE MIXTURES—OPEN CUP METHOD

No corrections for pressure have been applied to the burning point results, as no correction table was available.

The kerosene before being used in these tests was filtered through filter paper to remove all traces of moisture fog.

DISCUSSION OF RESULTS

The tables and accompanying Figs. 4, 5 and 6 show the results obtained by these tests. Blank spaces in the tables show that the tests were either unable to be carried out because of the low temperature required or the test was considered unsafe.

FLASH AND BURNING POINTS OF "LOW-TEST" GASOLINE AND KEROSENE

Gasoline by volume, per cent	0	1	2	5	7.5	10
Kerosene by volume, per cent	100	99	98	95	92.5	90
Open cup flash point, deg. F.:						
Without barometric correction	118.4	105.8	100.4	84.2	65.3*	35.6*
With barometric correction	120.0	107.4	102.0	85.8	67.0*	37.2*
Foster cup flash point, deg. F.:						
Without barometric correction	128.9	119.3	114.5	95.0	88.6*	.....
With barometric correction	130.5	120.9	116.1	96.6	90.2*	...
Burning point, deg. F	134.6	125.6	122.0	112.1	99.5*	78.8*

Gasoline used: "Low-test."
Specific gravity = 0.738 = 59.7 deg. B. at 15.5 deg. C.
Kerosene used:
Specific gravity = 0.815 = 41.8 deg. B. at 15.5 deg. C.
Shows that freezing mixture was used in bath.

FLASH AND BURNING POINTS OF "HIGH-TEST" GASOLINE AND KEROSENE

Gasoline by volume, per cent	0	1	2	5	7.5	10
Kerosene by volume, per cent	100	99	98	95	92.5	90
Open cup flash point, deg. F.:						
Without barometric correction	118.4	104.0	95.0	78.8	63.5*	30.2*
With barometric correction	120.0	105.3	96.3	80.1	64.8*	31.5*
Foster cup flash point, deg. F.:						
Without barometric correction	128.9	118.3	114.0	90.5	82.6*	.....
With barometric correction	130.5	119.6	115.3	91.8	83.9*	.....
Burning point, deg. F	134.6	118.8	114.8	105.8	95.0*	71.6*

Gasoline used: "High-test."
Specific gravity = 0.703 = 69.15 deg. B. at 15.5 deg. C.
Kerosene used:
Specific gravity = 0.815 = 41.8 deg. B. at 15.5 deg. C.
* Shows that freezing mixture was used in bath.

FLASH AND BURNING POINTS OF PETROLEUM ETHER AND KEROSENE

Petroleum ether by volume, per cent	0	1	2	3
Kerosene by volume, per cent	100	99	98	97
Open cup flash point, deg. F.:				
Without barometric correction	118.4	84.2	62.6*	24.8*
With barometric correction	120.0	85.8	64.2*	26.4*
Foster cup flash point, deg. F.:				
Without barometric correction	128.9	103.7	77.3*	.....
With barometric correction	130.5	105.3	78.9*	.....
Burning point, deg. F	134.6	118.4	105.8*	87.8*

Petroleum ether used:
Specific gravity = 0.635 = 89 deg. B. at 15.5 deg. C.
Kerosene used:
Specific gravity = 0.815 = 41.8 deg. B. at 15.5 deg. C.
* Shows that freezing mixture was used in bath.

In the open cup method the flash points of the "high-test" gasoline-kerosene mixtures were naturally lower than the corresponding mixtures of "low-test" gasoline, being a minimum of 2.1 deg. F. less at 1 per cent and 7.5 per cent gasoline and a maximum of 5.7 deg. F. less at 10 per cent gasoline. The fact that a minimum difference occurred at both 1 per cent and 7½ per cent shows that the open cup flash point of the "low" and "high" test gasoline-kerosene mixtures did not fall at the same rate with increase in percentage of gasoline.

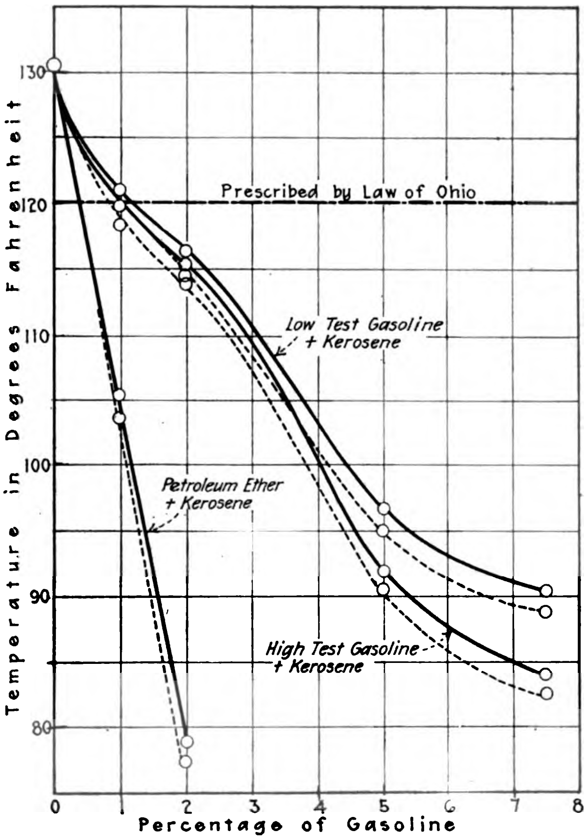


FIG. 5. FLASH POINTS OF GASOLINE-KEROSENE MIXTURES—FOSTER CUP METHOD

In the case of the closed cup the flash points for mixtures above 2 per cent high and low test gasoline regularly fall at different rates, with increase in concentration of gasoline as shown by the curves falling away from one another. This shows that the open cup method does not bear a constant relation to the closed cup method, or, graphically speaking, their curves are not the same shape.

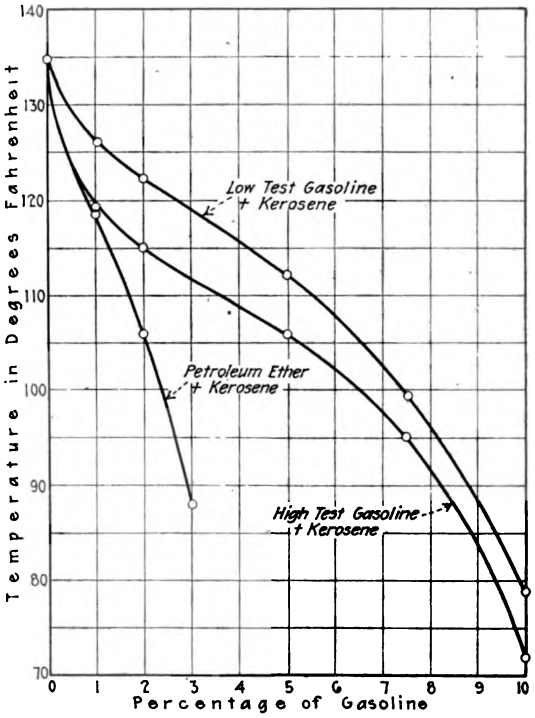


FIG. 6. BURNING POINTS OF GASOLINE-KEROSENE MIXTURES

The flash point of the petroleum ether-kerosene mixtures decreased regularly with increase in concentration of petroleum ether so that in the case of the open cup method the curve was almost a straight line, and in the case of the closed cup method it was a straight line.

The lowering in the flash point of kerosene by adding petroleum ether was remarkable. In the open cup method 2.9 per cent petroleum ether lowered the flash point of the kerosene about 88.5 deg. F. or as much as for 10 per cent high-test gasoline. In the case of the closed cup method 1.8 per cent petroleum ether lowered the flash point about 47 deg. or the same as for 7.5 per cent of high-test gasoline.

The decrease in the open cup flash points for the gasoline-kerosene mixture was somewhat over 1.3 times as much as the decrease in the burning point for the same concentration of gasoline. For example, 10 per cent low-test gasoline lowered the flash point 82.8 deg., whereas it lowered the burning point but 55.8 deg.; 10 per cent high-test gasoline lowered the flash point 88.2 deg. and the burning point 63.0 degrees.

In the case of the petroleum ether-kerosene mixtures the flash point was lowered just about twice as much as the burning point, e.g., 3 per cent petroleum ether lowered the flash point 93.6 deg. and the burning point only 46.8 degrees.

The burning point curves are of about the same shape as the open cup flash point curves, showing that in the case of the high and low test gasoline-kerosene mixtures the burning points did not decrease at the same rate as each other. In making up mixtures, the order of addition did not affect results, though such a difference is possible for a time at least on a larger scale.

It is evident that the flash and burning points of kerosene are greatly reduced by small admixtures of more volatile petroleum fractions, such as gasoline, so that grave danger can easily result therefrom.

Distillation Tests of Fractions Used

In order that the oils used in this work may be identified the specific gravity was determined by the hydrometer method and distillation cuts of the oils obtained.

The distillations were carried out as prescribed in Technical Paper 166 of the Bureau of Mines, with the addition of reading the number of cubic centimeters distilled every 5 deg. rise in temperature as recorded by the thermometer as well as readings at every 10 per cent by volume.

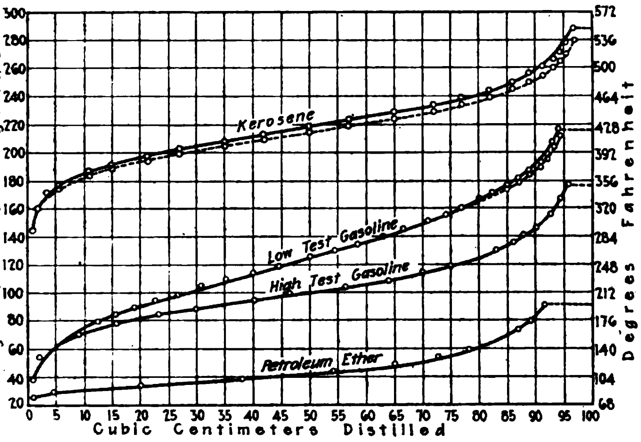


FIG. 7. DISTILLATION CURVES OF THE OILS TESTED

The 250 cc. flask connected with the condenser was filled with 100 cc. of the oil measured in a 100 cc. cylinder. The same cylinder was then used as the receiving vessel. In the kerosene and gasoline distillation the flask was covered with an asbestos box; this being omitted in the distillation of the petroleum ether. Heat was applied so that the distillation proceeded at the rate of about 5 cc. per min., the entire distillation requiring about 25 min. The thermometer used in these distillations was the same as that previously described as being used for the open cup flash and burning point determinations. Besides applying the calibration correction, a correction was added for the emergent stem of the thermometer, varying up to 2.5 deg. C. Formula for corrections was obtained from "Physico Chemical Tables," Castell Evans, vol. 1, p. 126, J. B. Lippincott Co., Philadelphia, Pa. The condenser trough was filled with cracked ice to insure complete condensation. There were from 2 to 3 cc. of residue left in the flask at the end of each distillation. The results obtained by the distillation are shown in the tables and curves following. Fig. 7 contains all of the oils in order that a comparison may be made between them.

No stem temperature correction was necessary in the case of the distillation of the petroleum ether, since the last fraction boiled off at 103 deg. C. as recorded by the thermometer and the emergent stem began at 105 deg. C. in all cases.

The solid curve represents the distillation when stem temperature corrections have been applied. The dotted curves represent the distillation without stem temperature correction.

E. W. Dean in his report on gasoline distillation (Bureau of Mines Technical Paper 214, p. 29) plots the dry point on the 100 cc. ordinate. This is not exactly correct, since the dry point is always obtained before 100 cc., the initial volume of gasoline, has been received. Plotting this results in the curve ending in a sharper bend than it should. To obviate this error, we have plotted the actual dry point on the curve where it is observed and extended a straight horizontal dotted line to the 100 cc. ordinate in order to show where the curve would come had Dean's method of plotting been used. This actually represents approximate loss in distillation.

For convenience, the ordinates are labeled both in Centigrade and Fahrenheit readings.

Temperature, Deg. C.	Deg. F.	Kerosene, cc.	Low-Test Gasoline, cc.	High-Test Gasoline, cc.	Petroleum Ether, cc.
24	75.2	....	....	....	1.0
29	84.2	....	....	....	4.5
34	93.2	....	....	....	20.0
38	100.4	....	1.0	....	....
39	102.2	....	....	....	38.0
41	105.8	....	....	1.0	....
44	111.2	....	....	....	54.0
49	120.2	....	1.5	....	65.0
54	129.2	....	2.0	....	72.5
59	138.2	....	3.0	....	78.0
64	147.2	....	5.0	4.0	....
69	156.2	....	9.0	5.5	....
71	159.8	....	....	10.0	....
74	165.2	....	10.5	....	87.0
79	174.2	....	12.5	15.5	89.0
84	183.2	....	15.5	23.0	90.0
89	192.2	....	19.0	30.0	91.0
92	197.6	....	....	....	91.5
94	201.2	....	22.5	40.0	....
99	210.2	....	26.5	46.5	....
104	219.2	....	30.5	56.5	....
109.2	228.6	....	35.0	64.0	....
114.2	237.6	....	40.0	70.0	....
119.3	246.8	....	44.5	75.0	....
124.5	256.1	....	50.0	81.0	....
129.6	265.3	....	54.5	83.0	....
134.7	274.5	....	58.5	86.0	....
139.8	283.7	....	63.0	88.0	....
145.0	293.0	1.0	66.5	90.0	....
149.1	300.4	....	71.0	92.0	....
155.3	311.5	1.4	74.0	93.0	....
160.4	320.7	1.8	77.0	94.0	....
165.6	330.1	2.4	80.0	94.5	....
170.8	339.4	3.3	82.0	95.0	....
175.9	348.7	5.5	85.0	96.0	....
181.2	358.2	8.5	87.0	....	....
186.3	367.3	11.0	89.0	....	....
191.5	376.7	15.0	91.0	....	....
196.7	386.1	21.5	92.0	....	....
201.9	395.4	27.0	92.5	....	....
207.1	404.8	35.0	93.0	....	....
212.4	414.3	42.0	93.5	....	....
217.7	423.7	50.0	95.0	....	....
222.8	433.2	57.0	....	....	....
228.1	442.5	65.0	....	....	....
233.4	452.1	72.0	....	....	....
238.7	461.7	77.0	....	....	....
244.0	471.2	82.0	....	....	....
249.3	480.7	86.0	....	....	....
254.6	490.3	89.0	....	....	....
260.0	500.0	91.5	....	....	....
265.3	509.5	93.5	....	....	....
270.3	518.5	94.5	....	....	....
275.7	528.2	95.5	....	....	....
281.3	538.3	96.0	....	....	....
286.9	548.4	97.0	....	....	....

DISTILLATION TESTS IN 10 PER CENT CUTS

	Petroleum Ether		High-Test Gasoline		Low-Test Gasoline		Kerosene	
*	Deg. C.	Deg. F.	Deg. C.	Deg. F.	Deg. C.	Deg. F.	Deg. C.	Deg. F.
10	31.0	87.8	71.0	159.8	73.0	163.4	185.0	365.0
20	34.0	93.2	83.0	181.4	90.0	194.0	195.6	384.1
30	36.5	97.7	89.0	192.2	103.7	218.6	204.2	399.5
40	39.5	103.1	94.0	201.2	114.2	237.6	210.3	410.4
50	43.0	109.4	101.0	213.8	124.4	256.1	217.6	423.6
60	47.0	116.6	106.0	222.8	136.7	278.0	225.1	437.0
70	52.0	125.6	114.2	237.6	149.0	300.2	232.3	450.1
80	61.0	141.8	123.9	255.0	165.6	330.1	241.5	466.6
90	84.0	183.2	145.0	293.0	190.0	374.0	256.9	494.5

* Volume in Percentage

We are indebted to Mr. Frank C. Vilbrandt, instructor of industrial chemistry in this laboratory, for material assistance in the search of the literature for data covering the ground of this report and kindred topics.

BRIEF BIBLIOGRAPHY

I. Adulteration of Kerosene with Gasoline.
  - Allen, Smithsonian Reports, 1861, 330.
  - Crew, "Treatise on Petroleum," 1887, 136, 395.
  - Brandt, "Petroleum and Its Products," 579.
  - Bacon and Hamor, "American Petroleum Industry," Vol. 2, p. 482.
  - Allen, "Commercial Organic Analysis," Vol. 2, part 2.
  - Thorpe, "Dictionary of Applied Chemistry," Vol. 4, p. 138.
  - Redwood and Eastlake, "Petroleum Technology," p. 227.
  - Redwood, "Petroleum and Its Products," Vol. 2, 542.

II. Effect of Additions of Gasoline on Flash and Burning Points of Kerosene.
  - Allen and Crossfield, "Fire Hazards."
  - Flash Points of Oils, Bureau of Mines Tech. Paper 49, p. 11.
  - Allen, Smithsonian Reports, 1861, pp. 334, 339.
  - Bacon and Hamor, "American Petroleum Industry," Vol. 2, p. 518.
  - Brandt, "Petroleum and Its Products," p. 417.
  - Crew, "Treatise on Petroleum," p. 359.
  - Redwood, "Petroleum and Its Products," Vol. 2, p. 543.
  - Allen, "Commercial Organic Analysis," Part 2, p. ii.
  - Redwood, "Petroleum and Its Products," Vol. 2, p. 506.
  - Steingräber, *Oesterr. Chem. Zeit.*, 1900, pp. 589-594; *J. Soc. Chem. Ind.*, 1901, p. 352.
  - Weibe and Hebe, "Petroleum," Vol. 7, p. 655 (*C. A.*, 1912, p. 1842).

III. Explosive and Inflammable Mixtures of Gasoline Vapors.
  - Redwood, "Petroleum and Its Products," Vol. 2, pp. 500, 503, 504, 508, 510.
  - Brandt, "Petroleum and Its Products," p. 417.
  - Allen, Smithsonian Reports, 1861, pp. 335, 340.
  - Burrell, U. S. Bureau of Mines Technical Paper 127, p. 9.
  - Burrell and Boyd, *ibid.*, No. 117.
  - Lucchini, *Ind. Chem.*, Vol 12, p. 658 (*C. A.* 1912, p. 1521).

IV. Other Factors Influencing Fire Hazards of Gasoline and Kerosene.
  - Burrell, U. S. Bureau of Mines Technical Paper 127, p. 11.
  - Allen and Crossfield, U. S. Bureau of Mines Technical Paper 49, p. 5.
  - *Chem. News*, Vol. 49, p. 196.
  - E. H. Ladd, 18th Annual Report North Dakota Experiment Station, pp. 34-42 (*C. A.*, 1909, p. 243).

V. Flash Point of Oils.
  - See thorough bibliography of Allen and Crossfield, U. S. Bureau of Mines Technical Paper 49, p. 31; 144 references.

Laboratory of Industrial Chemistry,
Ohio State University,
Columbus, Ohio.

The Liability for Infections[*]

BY CHESLA C. SHERLOCK

THE workmen's compensation acts have brought many new problems as to their own liability before employers. Not only that, but they have caused no amount of uncertainty among courts as to just what this liability amounts to.

The compensation acts serve to secure the payment of compensation to workmen who are incapacitated by means of an accidental injury "arising out of and in the course of" the employment. This naturally limits the employer's liability somewhat, but at the same time it raises a point of controversy over what is meant by the term "accident."

The courts have decided, and with good judgment, that the meaning to be given the word accident shall be its ordinary and usual meaning and that it cannot be given a technical meaning if the ultimate purpose of the compensation acts is to be kept in mind and preserved. So, they have said that an accident is any unlooked for and untoward event happening within chance and without design or intention. If a workman suffers such an accident which arises through the employment and out of it, then he is clearly entitled to compensation.

But it is the fitting of specific cases that come up to the studied expression of the statutes and of judicial opinions that causes the real difficulty. For instance, the question of whether an infection is an accident or not has caused no end of litigation under the acts. It is a well-known fact that workmen engaged in certain occupations are constantly subjected to the hazard of infection. Those who work with paint and stains are in constant menace; those who work in refuse and débris are constantly in danger of experiencing blood poisoning, and those engaged in certain other specific occupations are constantly subjected to the danger of infection through both the blood and the lungs by reason of the materials they work with, the fumes they breathe, or the inherent nature of the work. The long list of cases being reported each year on this subject alone is ample authority for this statement.

In the earlier days of the compensation practice the courts were called upon almost in the first cases to decide whether or not diseases were accidents. They held in diverse opinions that they were and they were not accidents. These decisions have since given rise to a series of rules which are more or less authoritative and which embody the present law upon the subject.

Unless specifically provided for in the statute, an occupational or industrial disease is not an accident within the meaning of the compensation acts. As to what constitutes an occupational disease there may be some doubt, but the courts have pretty well defined it.

One authority states: "An occupational disease is a disease caused by or especially incident to, a particular employment."

In a New York case, the court said: "An accidental injury . . . is clearly distinguishable from an injury in the nature of a vocational disease, sustained in the course of the employment, where, from the inherent nature of the work, disease is likely to be contracted."

TRAUMATIC DISEASE

It is well known that where certain work is followed certain diseases are very apt to be contracted if the workman persists in following that employment very long. Among the most common of these diseases are various forms of poisoning such as lead and copper poisoning. Since these diseases are of an inherent danger to the work, the courts have almost uniformly held that they are not an "accident" and the workman is not entitled to compensation, unless the act specifically mentions occupational diseases, in case he suffers from one.

---

[*] Other articles by this author on the same general subject have appeared in CHEM. & MET. ENG. as follows: "The Explosion of Chemicals—Common Law Liability," Vol. 21, No. 2, July 15, 1919, p. 83; "The Explosion of Chemicals—Workmen's Compensation Acts," Vol. 21, No. 3, Aug. 1, 1919, p. 131.

The rule, however, is different in Massachusetts and other States where the compensation is payable not for accidental injuries, but for "personal injuries." The court of Massachusetts has said that an occupational disease is a personal injury within the meaning of the Massachusetts act. This does not say, however, that all diseases are deemed to be non-compensable in the opinion of the courts. While occupational diseases are excluded because they form a distinct class of their own, there has been a clear reservation on the part of other, ordinary forms of diseases.

The rule is well settled that if the disease is clearly the result of the employment, or that the employment subjected the workman to a greater hazard to the disease than he would have been subjected to in ordinary employment, or if the disease resulted from an accidental injury, then the workman will be entitled to compensation. This is what is known as the "traumatic disease" theory. If the disease has its origin in trauma, or injury, then it is clearly an accident within the meaning of the acts. For instance, a workman falls off a trestle or a train of cars and because of his injuries and bruises about the chest contracts pneumonia. This is a compensable disease within the meaning of the compensation acts.

Or, another illustration: A workman is required to work for several hours in cold water in order to save a levee or other property of his employer from damage or destruction. Because of the unusual exposure he contracts pneumonia. This is a compensable disease within the meaning of the compensation acts.

INFECTION CASES MORE DIFFICULT

Still another case might be given: A workman is required to clean up débris following a wreck. He scratches his hands and contracts blood poisoning from handling the débris and refuse matter. This is a compensable disease within the meaning of the compensation acts.

Infection, because of its nature, is often a harder matter to determine than a mere disease. An infection, being of such slow and insidious origin that it is extremely difficult to trace it, presents an entirely different problem than an ordinary disease, the symptoms of which generally have their root in some event or happening within the employment. A workman may be able to determine, from his exposure and the like, where he got his disease, but not be able to state just where he got his infection.

It is necessary, however, that the infection be linked up to the employment by some certainty as to time and place and the circumstances under which it was acquired. Generally, employers resist claims for blood poison, for instance, unless the workman reports every little scratch and cut he receives *at the time.* It is so easy for one to pick up such infections outside the employment that employers are certainly justified in taking these steps for self-protection.

Where the employment is clearly to blame for certain infections, however, the courts will not be too technical in their requirements. In one case a workman employed to mow weeds along a right of way contracts poisoning on his hands and face. He was allowed compensation, it not being necessary for him to prove specifically the exact instance when he encountered the poisonous substance which incapacitated him.

The compensation acts are administered in a "spirit of true helpfulness" whenever possible, and they will include infections and diseases within the limitations mentioned above.

Ammonia in Producer Gas*

BY F. K. OVITZ

Assistant Chemist, Bureau of Mines

THE tests described in this paper were made at factory No. 2 of the Hazel-Atlas Glass Co., Washington, Pa., in co-operation with Mr. C. E. Frazier and Mr. C. D. Smith of that company. The object of the tests was to determine the amount of ammonia in gas from producers of the Smith type. At the time the tests were made the importance of ammonia for munitions, refrigeration and agriculture made it desirable that all possible sources of supply should be utilized.

For ammonia-recovery, gas-producers can be divided into two general classes.

1. Producers gasifying the fuel at a low temperature with a comparatively large amount of steam, 3 to 4 lb. of steam per lb. of coal.
2. Producers gasifying the fuel at a high temperature and using a comparatively small amount of steam, about 1 lb. per lb. of fuel.

From the first, or Mond type, 15 to 20 lb. of ammonia, (NH_3), or 60 to 80 lb. of ammonium sulphate, $(NH_4)_2SO_4$, can be recovered per ton of bituminous coal. Information on the quantity of ammonia in gas from the second type, to which the Smith producer belongs, was not available.

DESCRIPTION OF TESTS

The producer plant consists of five producers with inclined grates, each grate having a projected area of 200 sq.ft. The coal is fed into the top of the producer through hoppers which are arranged so that they will distribute it uniformly over the top of the fuel bed. The thickness of the fuel bed during the tests was about 5 feet. The bed was kept in good condition and as free as possible from holes by hand-poking.

The coal used was from the Pittsburgh bed in Washington County, Pa., and contained about 1½ per cent of nitrogen on the moisture and ash-free basis. The size was not uniform; at times fairly clean coal of No. 1 nut size was used, while at other times a large amount of fine coal was mixed with it.

Air saturated with steam at 150 to 160 deg. F. was used to gasify the coal, about 4 lb. of air and 1 lb. of steam being used for each pound of coal. The gas was cleaned before being used. From each producer the gas passed through a "hot pipe" into a "downcomer," from which it entered the bottom of a primary scrubber, where it was cooled to about 140 deg. F. by water sprays. From the top of the primary scrubber the gas passed into a large header, where gas from all the producers mixed to some extent. From this header it was sent by exhausters through the tar filters and finally through the secondary scrubbers, where it was washed with water again and cooled to about 100 deg. F. and then delivered into the gas main.

---

*Published by permission of the Director of the Bureau of Mines.

The water used in the system was cooled in a spray pond and recirculated. The water and tar from the scrubbers and that collected in the header ran into a common drain which emptied into the tar well, where tar was separated from the water. The water was pumped from the tar well to the spray pond, where it was cooled and then returned to the scrubbers.

Gas from a single producer was used for most of the tests. For total ammonia in the gas an open-end sampler was placed in the "hot pipe" about 5 ft. from where the gas left the producer. The sample of gas was passed through the following system to absorb the ammonia and measure the volume:

1. Bottle which served as a trap for condensed water and tar.
2. Four wash-bottles containing dilute sulphuric acid.
3. Filter made from asbestos fiber.
4. Experimental wet meter.

Suction was supplied by a small steam aspirator. The first two tests showed that it was very important to collect all the water which condensed from the gas because a considerable part of the ammonia was dissolved in it. For this reason in subsequent tests bottle No. 1 was arranged so that moisture and tar which condensed in the sampler could drain into it. To determine volatile and fixed ammonia, distilled water was used in the wash bottles in place of dilute sulphuric acid. Gas was drawn through the apparatus at a rate of about 1 cu.ft. per hour.

The liquid from all the bottles was made up to a definite volume. The ammonia in an aliquot part of this volume was determined by adding strong caustic soda solution, distilling and absorbing the ammonia in a measured volume of standard decinormal sulphuric acid. The acid which was not neutralized by ammonia was titrated with standard decinormal caustic soda using cochineal as indicator. The quantity of ammonia per ton of coal was calculated from the results of the titration and the volume of gas produced, by means of the formula given below. While no exact measurement of the quantity of gas produced per ton of coal could be made, 130,000 cu.ft. is assumed for the purpose of making the calculations and is believed to be sufficiently accurate for practical purposes. The weight of ammonium multiplied by 3.8787 gives the weight of ammonium sulphate per ton of coal.

$$\frac{\text{cc. of N/10 acid} \times 0.0017 \times 130{,}000}{\text{cu.ft. of gas in sample} \times 453.6} = \text{lb. NH}_3 \text{ per ton of coal}$$

The quantity of ammonia in the gas at various points in the system is given in Table I. All gas volumes are expressed in cubic feet at 60 deg. F. and 30 in. of mercury. Tests Nos. 1 and 2 were made with a large tar filter in front of the wash bottles and the results given on these are low, due to condensation of water vapor from the gas and absorption of ammonia by it. These results should not be used in computing averages. Tests Nos. 7, 9, 10, 11, 12 and 13 were made with distilled water in wash bottles in order that the proportions of fixed and volatile ammonia can be determined.

In addition to the quantity of ammonia in the gas, the percentage of ammonia in the liquor from the tar well and spray pond was determined. The results of these determinations are given in Table II.

An average of 5.70 lb. NH_3, or 22.11 lb. ammonium sulphate, was found in the raw gas as the result of seven tests. While the variation between individual tests was quite large, it was no greater than might be expected on account of the changing conditions in the producers during the time tests were being made.

TABLE II. AMMONIA IN LIQUOR FROM TAR WELL AND FROM SPRAY POND

Liquor	Specific Gravity at 15 Deg. C.	Free NH_3 per Cent by Weight	Total NH_3 per Cent by Weight
Tar well	.....	.....	0.614
Tar well	1.018	0.057	0.732
Spray pond	1.017	0.072	0.687

No detailed study was made of the effect of these changing conditions on the amount of ammonia in the gas, but by watching the variations which occurred in the experimental results and the condition of the producer, it was apparant that the temperature in the top of the producer was a very important factor. The rate of gasification and the amount of steam used, within the limits of daily variation, did not affect results noticeably. Whatever effect these factors had was less than that due to the temperature of the top of the producer.

The temperature in the top of the producer appeared to be influenced by the condition of the fuel bed more than by any other factor. If the fuel bed was not kept free from holes, unconsumed air passed through it and the oxygen burned with gas in the top of the producer, thereby raising the temperature. It required almost constant attention to keep the fuel bed free from holes, and at times it was impossible to do so. Since high temperatures are unfavorable to the formation and production of ammonia, it is very necessary to maintain as low a temperature as possible in the top of the producer

TABLE I. AMMONIA IN GAS

Test No.	Description of Sample	Volume of Gas Used Cu.Ft. at 60 Deg. F. and 30 In. Hg. Saturated With Water	Yield in Ammonia—Lb. per Ton of Coal					
			Total		Free		Fixed	
			As NH_3	As $(NH_4)_2SO_4$	As NH_3	As $(NH_4)_2SO_4$	As NH_3	As $(NH_4)_2SO_4$
1*a*	Raw gas from "hot pipe"	4.253	0.65	2.52	....	....	....	....
2*a*	Raw gas from "hot pipe"	15.636	2.30	8.92	....	....	....	....
3	Raw gas from "hot pipe"	25.249	5.41	20.98	....	....	....	....
4	Raw gas from "hot pipe"	20.638	6.72	25.96	....	....	....	....
5	Raw gas from "hot pipe"	22.832	4.34	16.83	....	....	....	....
6	Raw gas from "hot pipe"	38.424	5.77	22.38	....	....	....	....
8	Raw gas from "hot pipe"	13.310	6.25	24.24	....	....	....	....
7*b*	Raw gas from "hot pipe"	25.377	6.38	24.75	4.96	19.24	1.42	5.51
10*b*	Raw gas from "hot pipe"	33.987	5.00	19.39	3.78	14.66	1.22	4.73
9*b*	Clean gas from main	25.746	0.41	1.59	0.40	1.55	0.01	0.04
11*b*	Clean gas from main	16.423	....	....	0.41	1.59	....	....
12*b*	Gas before entering secondary scrubber	11.576	2.57	9.96	2.46	9.54	0.11	0.43
13	Gas after passing primary scrubber	19.501	....	....	2.10	8.15	....	....

a Tests 1 and 2 made with large filter, not used in calculating average results.
b Test made with distilled water in wash bottles.

in order to obtain the best yield of ammonia. The quantity of ammonia found in the gas from one ton of coal was of the same general magnitude as is obtained from the carbonization of one ton of coal in a retort or by-product coke oven. This seems to indicate that the ammonia obtained comes from the destructive distillation of the coal taking place at the top of the fuel bed, and that very little comes from nitrogen liberated during gasification of the fixed carbon. If ammonia is formed from nitrogen liberated during gasification of the fixed carbon, it is apparantly broken up by the passage through the hot fuel bed before reaching the top.

Between 20 and 25 per cent of the total ammonia is in the form of fixed ammonia salts and the remainder is in the form of volatile or free ammonia.

Practically all of the fixed ammonia is absorbed in the water used for scrubbing the gas and accumulates in the pond liquor. Most of it is absorbed before the gas reaches the secondary scrubber, as shown by test No. 12. At the time of the tests the quantity of ammonia in the tar well and pond liquor averaged 0.678 per cent by weight, practically all of it being fixed ammonia. This percentage varies from day to day with the quantity of water in the pond. When fresh water is added to the pond to make up for loss by evaporation, the percentage decreases temporarily, but the total quantity in the pond increases steadily in proportion to the volume of gas scrubbed by the liquor.

Practically all of the volatile ammonia is absorbed in the scrubbing water and later dissipated into the air at various points throughout the system. Tests Nos. 9 and 11 show that the cleaned gas contained only about 0.4 of a pound of ammonia per ton of coal, practically all of which was in the volatile form. The exact distribution of the volatile ammonia was not determined. It depends upon the temperature of the scrubbing water at different points in the system and varies from day to day with the changes in these temperatures and the quantity of water.

It is possible to recover practically all of the ammonia in the gas, either by cooling sufficiently and scrubbing with cold water, or by treating with sulphuric acid. However, because of the low concentration of the ammonia in the gas, less than one-tenth that of by-product oven gas, and the large volume that consequently must be treated per lb. of ammonia recovered, the cost of equipment and recovery would be high. For example, to obtain the ammonia from one ton of coal used in a gas producer, about 130,000 cu.ft. of gas would need to be treated, whereas if the coal were used in a gas retort or by-product oven, about 10,000 cu.ft. would have to be treated and the quantity of ammonia recovered in both cases would be approximately the same. The fixed ammonia, ammounting to about 1.25 lb. per ton of coal, can be recovered by distilling the pond liquor with lime.

House Passes Tungsten Protection Bill

On Aug. 21 the House of Representatives passed the Timberlake bill providing for a tariff of $10 a unit on tungstic oxide, which amounts to $10 a ton on crude tungsten. Manufactured tungsten products must pay twice the amount, or $1 per lb. This tariff, in addition to the estimated import price of $8 to $10, will fix American tungsten at $18 to $20 and thus enable domestic producers to compete with imported ore from China and South America, upon which there is no tariff at present.

Recent Chemical and Metallurgical Patents

Complete specifications of any of the United States patents abstracted herein may be obtained by remitting 5c. each to the Commissioner of Patents, Washington, D. C.

Utilization of Tin Scrap.—A method of separating iron and tin based upon the fractional distillation of their chlorides is employed by DANIEL A. and SIDNEY H. WILCOX of Garden City, N. Y., for the utilization of tin scrap. The scrap is compressed and heated in a suitable furnace to such a temperature that a vigorous reaction ensues when chlorine is passed over the metal, both metals being volatilized as chlorides. Or, the scrap may be melted and the chlorine passed through or over the melted metal contained in a bessemer converter, reverberatory, cupola or blast-furnace, electric melting furnace or muffle furnace. In either case, the mixed chlorides are separated by fractional condensation. The tin chloride may be converted into metallic tin or tin oxide by well known methods. The ferric chloride is dissolved in water, reduced to ferrous chloride by passing the solution over hot iron and electrolyzed, using insoluble electrodes, so that the products are pure iron (some occluded hydrogen is present, but this may be removed by heat) and chlorine gas, which may be utilized for the treatment of additional quantities of scrap. (1,310,381; July 15, 1919.)

Method of Producing Lead Salts.—RALPH M. HARRINGTON has developed an electrolytic method for producing white lead and other lead salts. White lead similar to that produced by the "Dutch process" may be produced in the apparatus here illustrated. A cell (1) with anode (2) and cathode (3); the cathode is surrounded by a diaphragm (5). The anolyte is a solution of sodium acetate, the catholyte contains in addition sodium hydroxide, carbonate and bicarbonate. The passage of a current though the cell produces lead acetate at the anode and sodium hydroxide at the cathode, thus, $2Na(C_2H_3O_2) + Pb = Pb(C_2H_3O_2)_2 + 2Na$ and $Na + H_2O = NaOH + H$. The catholyte is circulated by the pump (15) to a carbonating tower (16), where it meets a current of CO_2. The NaOH produced at the cathode and this

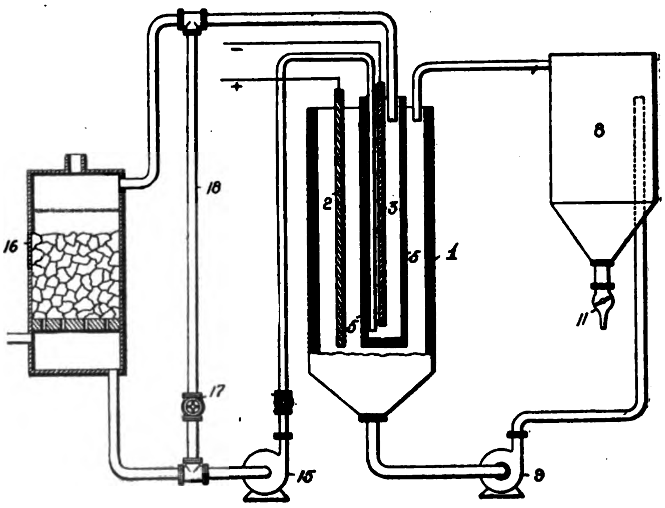


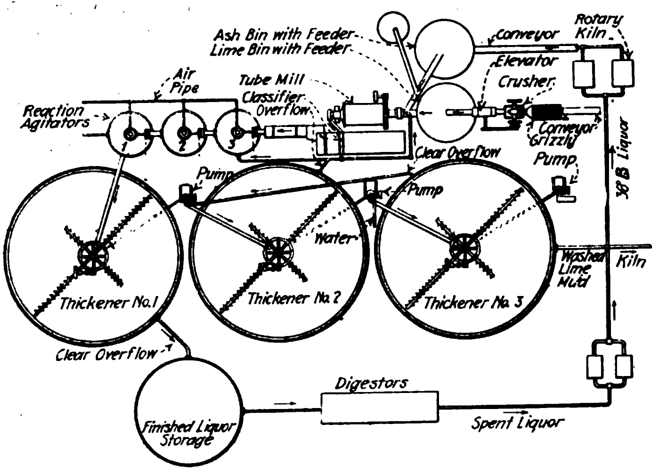
DIAGRAM SHOWING ELECTROLYTIC METHOD OF PRODUCING LEAD SALTS

CO_2 react to form sodium carbonate, thus $3NaOH + CO_2 = Na_2CO_3 + NaOH + H_2O$. This sodium carbonate reaches the anolyte by diffusion through the diaphragm and there reacts with the lead acetate to form white lead.

$$3Pb\,(C_2H_3O_2)_2 + 2Na_2CO_3 + 2NaOH = 2PbCO_3PbO_2H_2 + 6Na(C_2H_3O_2)$$

The white lead precipitated under these conditions does not adhere to the anode but settles to the bottom of the cell. From here it is drawn off by a pump (9) into a tank (8), where the settling is complete, the white lead being removed through a valve (11). Electrolytic white lead low in carbonate is amorphous, while that high in carbonate is crystalline. The proper control, by means of the bypass (18) and valve (17) of the amount of carbon dioxide supplied the catholyte, determines the quality of the product. (1,308,948; assigned to E. A. Sperry, July 8, 1919.)

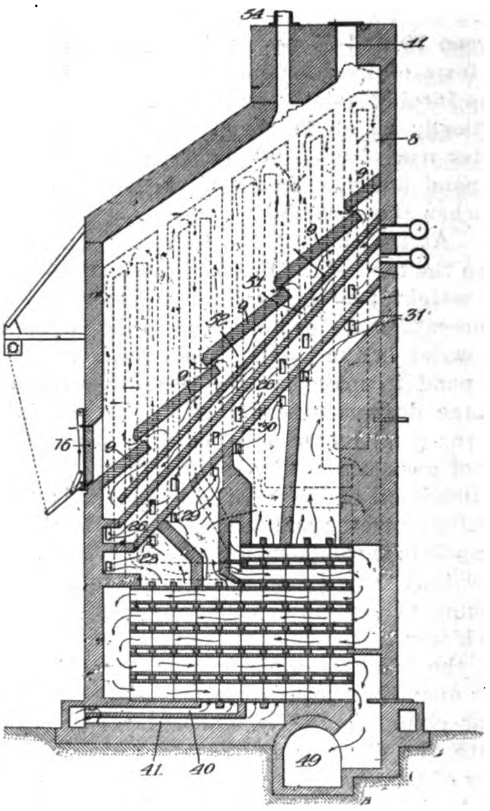
Caustic Soda From Black Liquor Ash.—DANIEL S. MCAFEE of New York City has combined the leaching and causticizing process as practiced in soda pulp paper mills. The spent liquor from the blown digestors is concentrated in vacuum evaporators to about 36 deg. B.—when its fuel value is sufficient to maintain combustion in a rotary kiln. The quenched cinder taken from the kiln contains from 70 to 85 per cent sodium carbonate and from 12 to 25 per cent carbon in a highly porous condition. Part of the soda used in each cycle is lost through adsorption on the cellulose pulp, in the finishing wash liquors and principally as sodium vapor in the black ash kiln. An amount of fresh soda ash sufficient to balance this loss is continuously added to the system together with the black ash and burned lime. The aggregate is pulverized and mixed in a tube mill with water and flowed into agitator tanks in which the causticizing is completed. The caustic soda liquor is removed from the lime carbon slime in Dorr thickeners. A diagram illustrating the operation of the process is given so that the compactness of the installation can be noted, which is an essential feature if the process is to be put in the average soda pulp plant. (1,308,184; assigned to the Dorr Co.; July 1, 1919.)



PROCESS OF OBTAINING CAUSTIC SODA FROM BLACK LIQUOR ASH

Separation of Molybdenum Ores.—T. R. FORLAND of Hangesund, Norway, patents a process for the separation of molybdenum from its sulphide ores. A current of chlorine gas, at a temperature above 268 deg. C., is brought into contact with the dried and pulverized ore or concentrate. Molybdenum chloride distills over and is separated from free sulphur and any metallic chloride having a lower boiling point by fractional condensation. In case the ore contains metals whose chlorides have a higher boiling point than that of molybdenum, the temperature may be so controlled that these chlorides remain in the tailings, from which they are recovered by leaching. (1,308,735; July 1, 1919.)

Shale Retort.—C. O. HOOVER of Denver, Colo., patents the retort illustrated, for treating material containing condensable hydrocarbons. It consists of a series of narrow, vertical retorts (8), charged through 11 and drawn at door 16. Volatile matter is withdrawn through 54 and passed through a series of condensers and a portion of the fixed gases returned for heating purposes. Another portion re-enters the retort itself, being preheated by passing chambers 51 and 52, thence working up into the charge between shelves 9 forming the floor of the retort. Such circulation not only equalizes the heat of the charge, but carries away evolved hydrocarbons before they break down. Arrows indicate the course of heating gases, entering the vertical flues through nostrils 26, there burning, thence passing down through the horizontal regenerating flues to waste tunnel 49. Air for combustion enters 40 and 41, works its way up around the horizontal regenerating flues, there being preheated, and is introduced to the vertical flues for combustion through nostrils 28, 29, 30 and 31. (1,305,109; May 27, 1919.)



SHALE RETORT

Electrode.—E. A. C. SMITH of New York City describes an anode for use in the electrolytic deposition of metals such as copper from an acid solution. The body of the anode is of silicon iron containing about 15 per cent silicon. Copper leads are cast into the anode and the melting of the copper is prevented by leaving the copper lead in contact with a chill plate at the bottom of the mold. (1,311,096; July 22, 1919.)

Synopsis of Recent Chemical and Metallurgical Literature

Manufacture of Synthetic Salicylic Acid.—An extremely practical description of the modern process for the manufacture of salicylic acid was given in a recent issue of the *Chemical Age*[1] by E. P. Wightman and George Robinson. Out of the many possible methods of synthesis, only two have achieved commercial success—the Kolbe and the Schmitt processes, which involve the following reactions:

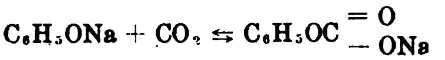
1. The formation of sodium phenate from phenol:

$$C_6H_5OH + NaOH = C_6H_5ONa + H_2O.$$

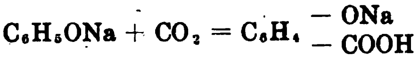
2. The phenate combines with carbon dioxide to give either

(*a*) sodium phenyl carbonate or

(*b*) o-carboxylsodium phenolate or some of both:

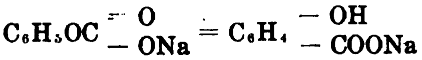
(*a*) 

$$C_6H_5ONa + CO_2 \leftrightarrows C_6H_5OC\begin{matrix}=O\\-ONa\end{matrix}$$

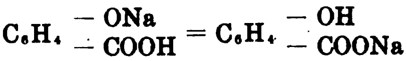
(*b*) 

$$C_6H_5ONa + CO_2 = C_6H_4\begin{matrix}-ONa\\-COOH\end{matrix}$$

3. The transformation of either of these into their isomer, sodium salicylate:

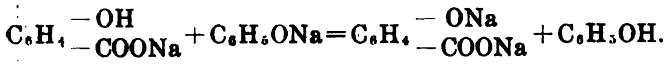
(*a*) 

$$C_6H_5OC\begin{matrix}=O\\-ONa\end{matrix} = C_6H_4\begin{matrix}-OH\\-COONa\end{matrix}$$

(*b*) 

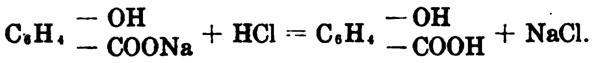
$$C_6H_4\begin{matrix}-ONa\\-COOH\end{matrix} = C_6H_4\begin{matrix}-OH\\-COONa\end{matrix}$$

4. Any unchanged or reformed sodium phenolate (by reversal of reaction 2*a*) combines with the sodium salicylate to form disodium salicylate and phenol:



$$C_6H_4\begin{matrix}-OH\\-COONa\end{matrix} + C_6H_5ONa = C_6H_4\begin{matrix}-ONa\\-COONa\end{matrix} + C_6H_5OH.$$

5. The free acid is precipitated from a solution of its sodium salt by hydrochloric acid:



$$C_6H_4\begin{matrix}-OH\\-COONa\end{matrix} + HCl = C_6H_4\begin{matrix}-OH\\-COOH\end{matrix} + NaCl.$$

The Kolbe synthesis requires a high temperature but works under atmospheric pressure. The disadvantages are that, under these conditions, reaction 2*a* goes from right to left and thus a large percentage of phenol remains unconverted (see equation 4). However, at least one large plant in this country is employing it with apparent success.

In the Schmitt process, the reversal of reaction 2*a* is prevented by increasing the active mass of carbon dioxide present. Pure sodium phenate is first prepared by melting an amount of U.S.P. phenol equivalent to 236 lb. 100 per cent phenol and stirring it into a hot solution of 100 lb. of 100 per cent caustic soda in 19 gal. of water contained in a jacketed autoclave, which must be made of bronze if the chemical method of purification (see below) is to be used. The phenate solution is evaporated under diminished pressure and finally dried to a fine powder, which must be perfectly dry, as the slightest trace of moisture will vitiate the results. After cooling, carbon dioxide is allowed to enter until the inside has attained atmospheric pressure and then at such a rate that a pressure of 10 lb. is reached within an hour. The temperature must be kept below 50 deg. C., since the reaction is exothermic. During the next hour the gas pressure is raised slowly to 100-110 lb. and the temperature to 130 deg. C. As soon as all the phenylcarbonate has been isomerized to salicylate, the partial (dissociation) pressure due to the phenylcarbonate disappears and the gage pressure registers a temporary drop. (The dissociation pressure of sodium salicylate is only 143 mm. at 220 deg. C., while that of sodium phenylcarbonate is greater than one atmosphere at 85 deg. C.) The gas pressure is cut off and, after heating for another hour, the mass is cooled and dissolved in hot water. The yield of crude sodium salicylate is from 98 to 99 per cent of theoretical.

There are two general methods of purification—the steam distillation, or physical, method and the precipitation, or chemical, method. For the first method, the free acid is precipitated from a hot solution of the crude sodium salt by adding 1 to 1 sulphuric acid, cooling and filtering. The acid precipitated cold is amorphous, is very difficult to centrifuge and holds water tenaciously. The acid is melted in an oil-heated still and distilled at a temperature of about 175 deg. C. by means of superheated steam. The condenser must be made of some non-ferrous alloy.

The product is a fluffy, white, needle-like crystalline acid with a faint odor of phenol (due to slight decomposition during distillation), which may be removed by washing with cold water in a centrifuge.

The chemical method employs stannous chloride as follows: In the purification kettle (preferably glass enameled, steam jacketed and provided with a stirrer) some of the solution of crude sodium salicylate is made faintly acid with C.P. sulphuric acid, heated to 90-100 deg. C. and treated in succession with:

(*a*) A solution of stannous chloride containing 2 to 3 per cent of tin salt by weight of the salicylate.

(*b*) Flake or powdered aluminum 1 to 1½ per cent. (This may or may not be used.)

(*c*) Acid-washed bone or blood charcoal (free from phosphates and iron); about 4 per cent.

(*d*) Concentrated sodium carbonate solution until neutral to litmus. If the solution remains either acid or alkaline, tin or aluminum or both may be carried through to the final product.

Filter hot through a filter press into a precipitating tank, which contains 1 to 5 sulphuric acid. Cool, centrifuge and wash in centrifuge with cold water until free from soluble salts. During the whole of the purification process, the solution must not come in contact with iron. The yield is 94 to 95 per cent theoretical, whereas the steam distillation rarely yields more than 90 per cent. The acid is dried on shelves in a room through which warm dry air at not over 60 deg. C. is drawn.

EDITOR'S NOTE.—The importance of salicylic acid as a dyestuff and medicinal intermediate is shown by the fact that 3,270,462 lb. of the U.S.P. grade, valued at $2,706,171, was produced by 13 firms in 1918. During the same period, eleven firms produced 1,395,630 lb. of the technical grade, valued at $799,337. The most important derivatives of salicylic acid used medicinally are: the sodium salt, acetyl salicylic acid (aspirin), phenyl salicylate (salol) and methyl salicylate. As a dyestuff intermediate, salicylic acid is used in the manufacture of alizarine yellow G (m-nitrobenzene-azo-salicylic acid) and other dyes which were used in large quantities during the war for the production of khaki.

---

[1] *Chemical Age*, vol. 1, July 25, 1919, p. 79.

Electric Production of Carbon-Free Alloys

By E. F. Northrup

A METHOD is now available and commercially perfected whereby any metal or alloy in granular form, in small broken pieces or in solid masses can be melted absolutely free from carbon and all other chemical contamination, provided this metal fuses at a temperature under the fusion temperature of pure zirconia.

The apparatus needed is a source of high-frequency current of 10,000 cycles per second or over, and a special type of induction furnace. This source of high-frequency current, in power units from 1 up to 100 kw., has been developed in the oscillatory current system which forms the major portion of the Northrup-Ajax high-frequency induction furnace. The complete theory of this method of electric heating by high-frequency induction has been given in a paper by the writer, presented at the April 3 to 5, 1919, meeting of the American Electrochemical Society.

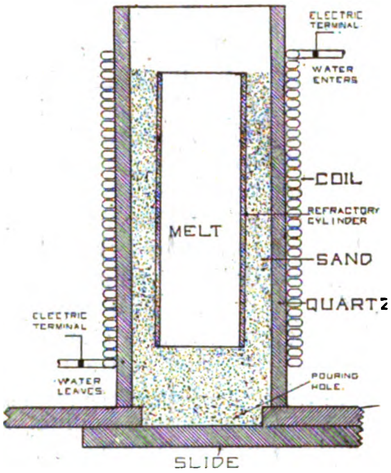


FIG. 1. CROSS-SECTION VIEW OF SCHEME OF FURNACE

The special type of induction furnace required for obtaining carbon-free melts is the subject of this brief sketch and is indicated in one of its forms diagramatically in Fig. 1. This diagram is almost self-explanatory. The tremendous concentration of energy produced by inductive action in a comparatively small volume makes it necessary to maintain the inductor coil cool by artificial means. To accomplish this cooling in a simple and effective manner, the material used for winding the inductor coil is a thin-walled, flattened copper tubing. It is flattened and wound edgewise to obtain the maximum possible number of turns to the inch. A small flow of water through this tubular coil maintains it always at the temperature of the tap water used.

The melt, which is located within the inductor coil and which may be only ½ to 1 in. less in diameter than the inside diameter of the coil, may be raised to a temperature of 2500 or 2800 deg. C., the coil remaining under 20 deg. C.

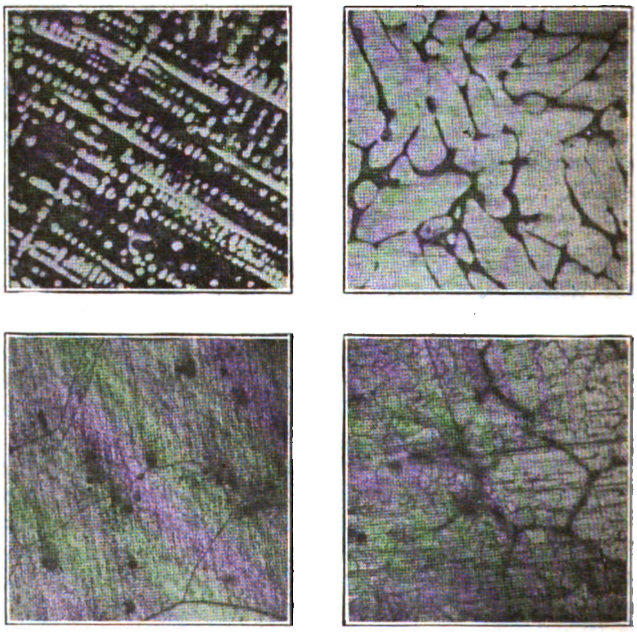
The procedure in making a melt of any electrically conducting material, such as electrolytic iron or nickel with which other metals are to be alloyed, is as follows:

A thin-walled crucible or open cylinder of fire-clay, magnesia, zirconia or like material is formed. This is located centrally in the inductor coil and the space outside and under this cylinder is filled in with fine alumina, silica or zirconia sand. The metal or component parts of the alloy to be produced is broken into small pieces, preferably about the size of walnuts, and packed in the thin-walled cylinder. When the high-frequency current is passed through the inductor coil rapid heating begins at once. This heating is due solely to the enormously large eddy currents which flow in the small conducting masses of the product being heated.

Melting of pure iron in lots of 2 to 5 lb. begins in from 10 to 20 min. and high super-heat is reached in 25 mm. When the mass has become completely molten, more material may be dropped in. The melted mass does not leak even though the thin-walled container cracks and breaks, for this is imbedded in a mass of sand which makes a natural metal-tight pocket. As soon as the mass becomes molten a very useful and interesting phenomenon is noted. The surface of the molten mass becomes much agitated and the central region of this surface is raised a considerable fraction of an inch above its circumferential region. The metal or alloy is in fact subjected to a vigorous stirring action. Metal flows vertically upward in the axial region and downward in the circumferential region, and thus an alloy becomes automatically most thoroughly mixed. This stirring action is not a thermal phenomenon, but is caused solely by the action of the electromagnetic forces. Its importance is easily recognized when a perfect mix of the constituents of the alloy is desired.

The following results are readily obtained in this method of heating:

1. All conducting materials may be raised to 2500 or 2800 deg. C. or to their vaporization temperature in an oxidizing atmosphere. Platinum is easily melted in this way.



MICROGRAPHS OF CARBON-FREE ALLOYS OF ELECTROLYTIC IRON. × 75

75% Cu = 25% Fe 25% Cu = 75% Fe
95% Fe = 5% Mo 92% Fe = 8% Cu

2. By placing the inductor coil on the outside of a quartz tube which is closed at both top and bottom, melts may be made in any atmosphere or in vacuum.

3. In the open type of furnace, the molten metal can be drawn off from the bottom into a mold.

4. The quantity of metal, Ni, Fe, Pt, etc., which

can be handled at a single melt is determined wholly by the size of the furnace employed and the power available. An inductor coil of 40 turns, 6 in. long by 3½ in. inside diameter, supplied with 10 to 20 kw., will melt 4 lb. of electrolytic nickel or iron at a charge in from 20 to 30 min. Larger furnaces supplied with larger power will handle larger quantities.

Palmer Physical Laboratory,
Princeton, N. J.

A New Compensated Heatmeter

By Charles P. Frey,
Chief Engineer, Brown Instrument Co., Philadelphia, Pa.

UNTIL comparatively recently the determination of furnace and kiln temperatures by means of thermocouples was attended with complications and difficulties which made practical men impatient and in some instances doubtful in regard to the intrinsic value and reliability of the method. Technical men, however, have realized from the beginning that, within certain temperature limitations, the results obtained by the use of thermocouples were not only accurate, but could be made "direct reading," provided the thermocouple be connected with a galvanometer which would indicate the actual value of the e.m.f. obtained by heating.

On first consideration, this problem did not seem difficult of solution, since it is is an established fact that the e.m.f. or voltage of a thermocouple bears a direct relation to the difference in temperature between its hot and cold ends. It is also true that the movable coil of a millivoltmeter will be deflected to an extent which is directly proportional to the e.m.f. of the thermocouple. Therefore it would seem the simplest operation imaginable to connect the thermocouple and the instrument by insulated conductors, figure the scale in temperature values, and regard the problem as solved.

Unfortunately, however, we have also to contend with factors which cannot be ignored if accurate results are required; namely, line resistance, thermocouple resistance and the resistance of the indicator itself; because, to be precise, a direct current millivoltmeter actually is not a millivoltmeter at all, except in name, but is a milliammeter or current indicator. All instruments of the d'Arsonval type depend primarily upon current for their operation, and the extent of the deflection obtained with any given current is established by the intensity of the magnetic field, the controlling force of the springs and the number of convolutions or ampere turns in the movable coil, and not by a remote e.m.f. Therefore, if the conductors which carry the current from the source of e.m.f. to the terminals of the instrument do not have a negligible resistance, then, in accordance with Ohm's law, there will be an appreciable fall of potential along the line, with the result that the movable system will receive a diminished current, and therefore be low in its readings. To reduce such errors to a minimum, it is desirable that the instrument resistance be as high as possible, so that the line and thermocouple resistance may be proportionately insignificant.

For instance, when this is not the case: If the resistance of the millivoltmeter M (Fig. 1) is 300 ohms and the resistance of the line A and thermocouple C is 3 ohms, the current through the circuit will be reduced practically 3 parts in 300, or 1 per cent, and the instrument indications will be 1 per cent low. Figured in degrees Fahrenheit, this would mean an error of approximately 14 deg. in 1400 deg. F., if a thermocouple were used.

The advantage of high-resistance instruments, therefore, becomes evident. For instance if the pyrometer has a resistance of 600 instead of 300 ohms, and the line resistance remains the same, an error of 3 parts in 600 will result, or only ½ of 1 per cent instead of 1 per cent. or about 7 deg. F. in 1400 deg. F.

Until within the last five years it was customary to use a so-called low-resistance pyrometer to measure the current from the thermocouple. These instruments had from 2 to 5 ohms internal resistance and were naturally materially affected by the external resistance of the thermocouple and leads. In the past few years high resistance pyrometers have been almost universally adopted. These instruments have an internal resistance of usually from 300 to 1200 ohms. The higher the resistance, naturally the less the effect on the readings due to variations in line resistance. But with increase in internal resistance, something had to be sacrificed, and usually control or torque is weakened. In consequence, the instrument is not as substantial or dead beat, and, due to the use of lighter springs, is more apt to be affected by spring fatigue.

It has been found by trial that an instrument of medium resistance (about 300 ohms) can be produced in a satisfactory and substantial form, but an instrument of this class is necessarily affected in its indications when leads of considerable length are employed. Material variations in the length of thermocouples are also a source of error, as well as the introduction of compensating leads. When compensating leads are employed, as well as long wires, in connecting the thermocouple with the instrument, it is a common practice to reduce the resistance of the instrument in order to offset the effects of line resistance. This is at best a method of doubtful value, since it interferes with checking the scale by comparison with a standard, and does not compensate for changes in the resistance of the line or thermocouple, due to variations in temperature.

Various devices and attachments have been made for use in connection with indicating and recording millivoltmeters and pyrometers, by means of which the instruments will remain direct reading, and at the same time be compensated for external or line resistance. Inventions of this class range all the way from a simple step rheostat connected in series with the "dead" resistor of the instrument to the elaborate and complicated apparatus employing the substitution and deflection methods, the potential of the thermocouple being first balanced against another potential derived from a dry cell; and after an intermediate operation and an intercomparison of deflections, the effect of line resistance is finally balanced out by a rheostat, and direct deflections are obtained from the thermocouple current.[1]

It remained for two physicists[2] of the Bureau of Standards, Washington, to offer an invention of theirs, which, incorporated in a Brown pyrometer, eliminates the effect of line and thermocouple resistance by means of an operation which is so simple that anybody can use the instrument and obtain accurate results. This improved heatmeter will unquestionably appeal to the practical man who wants results and does not care especially how the instrument functions, provided its indications can be relied upon.

---

[1] The Brown precision heatmeter.

[2] Paul D. Foote and T. R. Harrison.

In testing with this apparatus all that is necessary is to connect the thermocouple with the instrument binding posts in the usual manner, press a button, turn a knob and take a reading, which will be the correct e.m.f. of the thermocouple at its hot end, even if the line is miles in length. In fact, the line may have as much as 15 ohms resistance.

For those who would like to understand the fundamental principle of the Harrison-Foote invention, and at the same time prefer a simple demonstration, the following explanation should be of interest, especially since it reduces the method to its most elemental form by substituting an ammeter in place of a pyrometer, and using cells instead of a thermocouple.

If *A* (Fig. 2) is an ammeter of negligible resistance in series with three resistors of 11, 8 and 11 ohms respectively, and an e.m.f. of 6 volts is impressed by a battery, also of negligible resistance, it is evident that the resistance in circuit will be 11 + 8 + 11 = 30 ohms, and by Ohm's law ($C = E \div R$) the current throughout the circuit will be 6 ÷ 30 = 0.2 amp. and the ammeter will indicate accordingly.

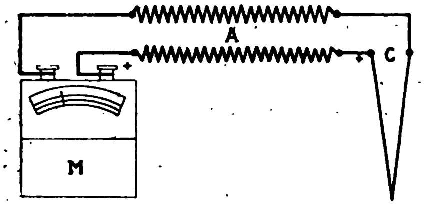


Fig. 1

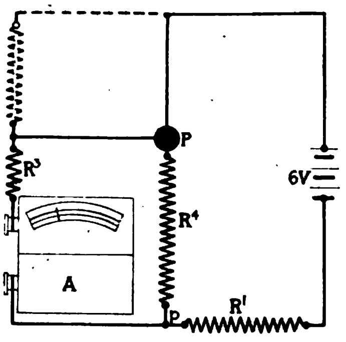


Fig. 3

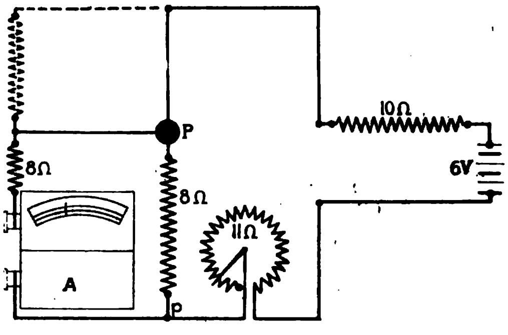


Fig. 5

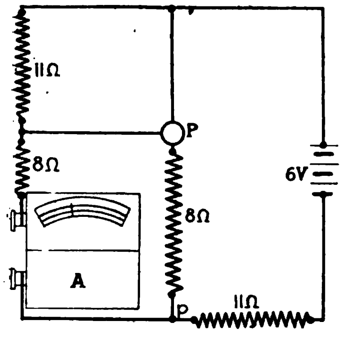


Fig. 2

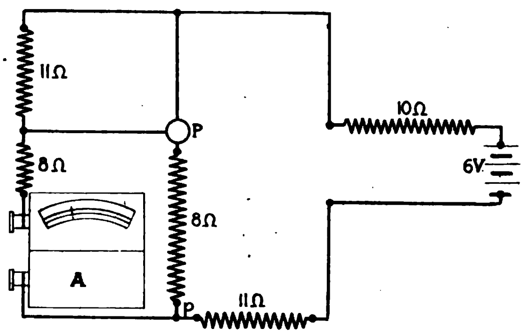


Fig. 4

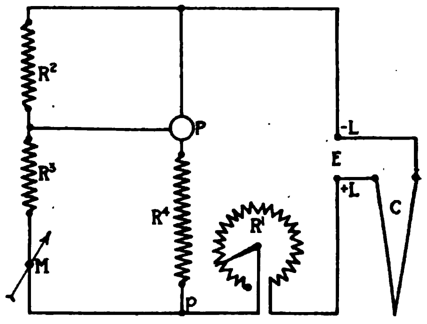


Fig. 6

If now (Fig. 3) a plug is inserted in *P*, the resistor R^2 will be short-circuited. By the same operation, the resister R^4, which also has a resistance of 8 ohms, will shunt or "by-pass" the ammeter, thereby robbing it of part of its current. In other words, the current splits when it reaches the plug, part of it going through R^3 and the ammeter, and the remainder through R^4, reuniting at *p* and passing through R^1, back to the battery.

The total current in this case will, of course, depend upon the total resistance in circuit. Since R^2 is cut out, the resistance will be

R^1 (= 11 ohms) + R^3 + R^4 (R^3 and R^4 are in parallel).

By the law of divided circuits, the resistance of R^3 and R^4 will be their product divided by their sum, or

$$(8 \times 8) \div (8 + 8) = 4 \text{ ohms}$$

the total resistance being 15 ohms and the current being 6 ÷ 15 = 0.4 amp., twice the current flowing in Fig. 2.

But it is obvious that, since R^3 and R^4 are alike in resistance, the current in splitting at *P* will divide evenly, half of it passing through the ammeter. Therefore the ammeter will indicate only one-half of the total current, or 0.2 amp., the same as in Fig. 2. Hence, under these conditions the deflection of the ammeter will not be changed whether the plug is in or out. If, however, 10 ohms of line resistance is added to the circuit (see Fig. 4) the current with plug out will be 6 ÷ (11 + 8 + 11 + 10) = 0.15 ampere.

With plug in, R^2 is cut out as before, and the total resistance will be

$$10 + 11 + (8 \times 8) \div (8 + 8) = 25 \text{ ohms},$$

and the current will be

$$6 \div 25 = 0.24 \text{ ampere.}$$

Of this current, one-half, or 0.12 amp., will pass through the ammeter. Its deflection will hence be less than in Fig. 2 when the plug is inserted, and the ammeter pointer will move down scale. To remedy this, let R^1 be in the form of a rheostat (Fig. 5). Then if the resistance of this rheostat is reduced an amount equivalent to the 10 ohms of line resistance, the conditions prevailing in Figs. 2 and 3 will be re-established, the line resistance will be compensated for, and the pointer will again indicate 0.2 amp., with plug in or out; all of which is very simple and self-evident after it has been demonstrated and explained.

In the actual construction of the instrument for technical and practical use, the movable system consists of a highly sensitive copper or aluminum wire coil suitably mounted in an intense magnetic field. In place of the plug *P*, a three-way press button is used. The shunt R^4 need not, of course, have a resistance equal to that of R^3; in fact it is preferable so to proportion it that the current through the circuit as a whole may be increased eight to ten times. The deviation of the pointer from normal will hence be large for even a very slight change in line resistance, permitting easy adjustment.

In practice the rheostat R^1 has a resistance of 15 ohms, subdivided into steps of approximately 0.05 ohm, so that the position of the pointer may be regulated with absolute exactness. In this connection it is in order to call attention to the fact that, while it is, of course, desirable to know what the range of the rheostat is, it is not at all necessary to know or attempt to determine what the line resistance may be. The rheostat is normally set at zero and, in testing for line resistance, is given a clockwise motion. In an experimental model the following proportions were adopted with excellent results (see Fig. 6).

Total resistance for 40 millivolts, 290 ohms.
Current without plug, 0.000138 ampere.
Current with plug, 0.00106 ampere.
Resistance of shunt, 26.25 ohms.
Movable system, 53.8 ohms, copper wire coil.
Rheostat, 15 ohms.

The temperature coefficient of the instrument was + 0.000365 deg. F. It is, of course, possible to construct these heatmeters with much higher resistances to meet special requirements, but excessively high values in ohms per millivolt are not factors of first importance in this type of pyrometer.

As already stated the shunt R^4 need not have a resistance equal to that of R^3, which is proved by the appended demonstration in which the following notations are employed:

R^1 = Maximum or "zero" position of rheostat.
R^2 = Resistance of ballast coil.
R^3 = Resistance of swamping coil and movable system in series.
R^4 = Resistance of shunt.
RL = Line resistance.
Rt = Sum of line resistance and resistance of rheostat when it is in any given position.
I = Current flowing through movable system.
E = e.m.f. of thermocouple at any given temperature.

In adjusting the instrument circuits at our laboratory, the resistors are so proportioned that

$$R^1 \div R^2 = R^4 \div R^3$$

The scale is graduated so that the instrument will give correct readings when

$$Rt = R^1$$

Assuming the instrument to be connected as in Fig. 6, and with plug out, then

$$I = E \div (R^2 + R^3 + Rt)$$

When the plug is in, the total current becomes

$$E \div [(R^3 \times R^4) \div (R^3 + R^4) + Rt]$$

Since the resistance of a divided curcuit (the swamping coil and movable system in shunt with R^4) is the product of the individual resistances divided by their sum, this current will proportion itself in the two arms of the divided circuit in inverse ratio to their resistances. Therefore

$$I = \left[R^4 \div (R^3 + R^4)\right]\left[E \div \left(\frac{R^3 \times R^4}{R^3 + R^4} + Rt\right)\right]$$

Or, simplifying

$$I = R^4 E \div (R^3 \times R^4 + R^3 \times Rt + Rt \times R^4) = E \div$$
$$(R^3 + \frac{R^3}{R^4} \times Rt + Rt)$$

The rheostat is adjusted so that this current equals the current obtained with plug out. Then

$$E \div (R^3 + \frac{R^3}{R^4} \times Rt + Rt) = E \div (R^3 + R^2 + Rt)$$

Therefore: $R^3 \div R^4 \times Rt = R^2$
or, $Rt = R^2 \times R^4 \div R^3 = R^1$

Since Rt now equals R^1, the instrument will give correct readings.

It is in order to add that, while an experimental model has been referred to for data, the development of these instruments has long since passed the experimental stage, and, in practical form, the improved Brown heatmeters, incorporating the Harrison-Foote method, have all of the following advantages:

They are direct reading throughout their entire scale range.
They require no dry cells or standard cells.
They are independent of line or thermocouple resistance.
They have a negligible temperature coefficient.

BROWN IMPROVED HEATMETER
HARRISON-FOOTE METHOD
THE BROWN INSTRUMENT COMPANY
DEGREES FAHRENHEIT

The operation of these instruments is simplicity itself. It cannot be questioned that such an instrument is a radical improvement on any of the various forms of electric pyrometers heretofore available and represents another noteworthy advance in pyrometry.

Production of Algin

Chemists throughout the country will be interested to know that the Hercules Powder Co. is devoting a good deal of attention to the extraction of algin from kelp. Algin is a substance whose properties are widely known, being a vegetable gum of extremely high viscosity. Its manufacture and use are on a firm footing in Europe, but so far the industry has never become well established in this country, largely, it is thought, because of difficulties in the way of securing a uniform supply of fresh kelp at a reasonable cost. The experience gained by the Hercules Powder Co. in harvesting kelp for the manufacture of war materials has overcome these difficulties as far as this organization is concerned.

There is a wide field of possible usefulness for algin. Algin compounds in general give an exceedingly viscous solution, and for that reason their application as a sizing for textiles and paper, as a thickener for printing colors and as a proofing for interior walls and ceilings is at once apparent. The sodium compound of algin is soluble in water, a 5 per cent solution thereof being so viscous that it can hardly be poured from a vessel. The compounds of the heavy metals with algin are insoluble in water, some of them being soluble in ammonia, which solvent is used in their application as a waterproofing material in textiles.

Book Reviews

AMERICAN METHODS IN FOREIGN TRADE, A GUIDE TO EXPORT SELLING. By *George C. Vedder*. ix + 204 pages. New York: McGraw-Hill Book Co., Inc.

The ability of a country to export a manufactured article or a product depends upon its quantity production in quantity more than sufficient for home consumption. The demand for any article is in the last analysis a function of its quality. The producer who gives most for value received acquires a business good-will which is the foundation upon which success is built. In competing in foreign markets the demand is in proportion to quality. Business success at home predicates success abroad, but there is the barrier of an international boundary and all that that connotes. The manufacturer who finds himself in the position to produce in larger quantities and requiring an extended market abroad will find in Mr. Vedder's book sound advice and authentic information gained through many years' intimate acquaintance with successful exporters. This book should serve as a guide in establishing a sound export selling policy.

Increased foreign trade is responsible for our more intimate association with other nations. It makes necessary certain phases of our Government's foreign policy. The chapters on the nationalization of foreign trade, foreign credits, American banks abroad, the merchant marine, reciprocity in foreign trade and the tariff are of interest to more general readers. They contain an analysis of the underlying conditions and the various factors which will broaden the reader's understanding in these matters.

L. W. CHAPMAN.

Personal

MR. ROBERT FOGELSON, formerly with the research division, Chemical Warfare Service, has accepted a position with the Newport Chemical Works, Inc., Carrollville, Wis.

DR. ELLIS I. FULMER, formerly of the faculty of arts, department of chemistry, University of Toronto, has accepted a position as assistant professor of chemistry, Iowa State University, Ames, Iowa.

MR. REGINALD E. HORE has resigned the editorship of the *Canadian Mining Journal* and is succeeded by **MR. F. W. GRAY**, formerly associate editor.

COL. W. R. LANG has relinquished his duties in Military District No. 2 to resume his chair as head of the department of chemistry, University of Toronto.

MR. HAROLD N. LAWRIE, chairman of the Board of the Oregon Bureau of Mines and Geology, has accepted the active chairmanship of the Division of Precious and Rare Metals in the American Mining Congress.

MR. DORSEY A. LYON has been made chief metallurgist of the Bureau of Mines, vice Dr. Cottrell, in conjunction with the position of supervisor of stations.

DR. VAN H. MANNING of the U. S. Bureau of Mines was in San Francisco Aug. 15 to 18 on a tour of inspection of the Bureau's experiment stations.

DR. ARTHUR C. NEISH, who for the past twenty years has been on the staff of the department of chemistry, Columbia University, New York City, has accepted the chair of chemistry at Queen's University, Kingston, Ont., and will undertake his new duties with the opening of the university in October.

MR. ROBERT F. REED has resigned his position as superintendent of the Norwood, Ohio, dye plant of the Ault & Wiborg Co. to accept a position in the Deepwater Point, N. J., dye plant of E. I. du Pont de Nemours & Co.

DR. R. F. RUTTAN, head of the chemical department of McGill University, Montreal, was in England during July, where he attended the International Convention of Chemical Societies in London, July 15, as representative of the Canadian Society of Chemical Industry.

MR. JEROME D. STEIN, formerly control supervisor of the nitrate division, U. S. Nitrate Plant No. 2, Muscle Shoals, Ala., has accepted a position with the Gordon Dryer Corporation.

MR. JACK A. THOMAS has resigned his position as department manager of the chlorinated products section of the Rollin Chemical Co. because of ill health.

Current Market Reports

The Non-Ferrous Metal Market

Monday, Aug. 25.—During the past two weeks, only minor fluctuations took place. Prices in general have assumed a normal bearing with regard to production costs and consumption offers.

Aluminum:—Transactions are mainly by direct contract. The open market continues quiet; 98-99 per cent ingots are quoted at 33c. per lb. Scrap casting, 21 to 24c.; sheet scrap, 22½-25c., and clipping, 24 to 27c.

Antimony:—The market is easy; spot wholesale is quoted at 8¾c. Job lots, 9c. lb.

Copper:—The market is firm with present quotations at 23½c. lb. and 24c. for the last quarter of the year.

Copper sheets, hot-rolled	lb.	33.50 —	......
Copper sheets, cold rolled	lb.	35.00 —	......
Copper bottoms	lb.	41.50 —	......
Copper rods	lb.	24.00 —	......
Copper wire	lb.	25.00 —	......
High brass wire and sheets	lb.	27.75 —	......
High brass rods	lb.	26.75 —	......
Low brass wire and sheets	lb.	30.50 —	......
Low brass rods	lb.	31.25 —	......
Brazed brass tubing	lb.	39.00 —	......
Brazed bronze tubing	lb.	44.25 —	......
Seamless copper tubing	lb.	37.50 —	......
Seamless bronze tubing	lb.	40.00 —	......
Seamless brass tubing	lb.	36.00 —	......
Scrap, heavy machinery comp		17 —	18
Scrap, heavy and wire		17 —	18
Scrap, light and bottoms		15 —	16
Scrap, heavy, cut and crucible		18½ —	19½
Scrap brass, heavy		10 —	11
Scrap brass, casting		12 —	13
Scrap brass, light		9 —	10
Scrap, No. 1 clean brass turnings		10 —	11
Scrap, No. 1 comp. turnings		15 —	16

Lead:—The dual lead market continues, the smaller producers quoting at a slight reduction, New York 5.8-6c. and East St. Louis 5.5-5.75c. lb. Cut sheet lead is bringing 9c.

Tin:—The freed tin market did not drop to as low a level as expected because large stocks are not available. Straits spots are at 58c. and electrolytic, 55½c.

Zinc:—Spot spelter has advanced to 7.9c. in New York and 7.5c. East St. Louis. Sheet zinc, 10c. lb.

OTHER METALS

Bismuth	lb.	$2.95 —	......
Cadmium	lb.	1.50 —	1.75
Cobalt	lb.	2.50 —	3.50
Magnesium	lb.	1.75 —	2.10
Mercury	75 lb.	101.00 —	......
Nickel	lb.	.41 —	.45
Iridium	oz.	175.00 —	......
Palladium	oz.	115.00 —	120.00
Platinum	oz.	105.00 —	110.00
Silver	oz.	1.13¾ —	......

The Iron and Steel Market

The second half of August constituted a crucial period in iron and steel market history. Labor unrest became more and more manifest. Strikes were not infrequent. Some were settled with little difficulty, but many were not settled. A strong feeling was shown among manufacturers against granting demands of men, as demands had become unreasonable. In some instances plants were closed upon the initiative of the management, trouble being in sight. Where strikes were settled the settlements involved small or no concessions, and some strikes that were allowed to go their way could probably have been settled by granting small concessions. Apart and probably entirely dissociated from these sporadic strikes was the general effort of the American Federation of Labor to unionize the entire industry.

On Aug. 26 there was published a plain and strong statement by President Wilson to the effect that there would have to be a truce in the demands of labor, and calling upon every one to assent. It is too early, at this writing, to observe widespread effects from this enunciation of a policy calculated to stop the "endless chain" or "vicious circle" of alternating increases in cost of production and increase in commodity prices, but the effects will undoubtedly prove very important. A turning point is probably marked.

Just before this statement was made by the President there was nothing in sight but difficulties. There was a strong possibility that a strike would be called or that plants would be closed in anticipation of strikes.

LABOR TROUBLES DOMINATE MARKET

The iron and steel market was dominated by the prospects of labor troubles. Producers became very reserved in their selling policies and in most finished products withdrew from the market except as to orders from regular customers. The mills were moderately well sold, but certainly not oversold. They feared they would be unable to produce anything like full tonnages.

Buyers were likewise influenced by the labor situation and prospects. A few buyers were moved to curtail their purchases because they did not wish to buy material when the mill obligation to deliver was qualified by strike and other clauses. The majority of buyers were influenced to offer greater tonnages to mills. Specifications against contracts were heavy and new purchases were attempted. The occasional or chance buyer generally failed to secure acceptance of his proffered orders.

The labor unrest had another effect upon the market. It made it clear to all producers except a few whose mental attitude is not readily explained that it would be extremely unwise to attempt to advance any prices. In June the Steel Corporation had allowed it to become known that as a settled policy the corporation was opposed to price advances, this year at any rate, and that view eventually became general. With mills fairly well sold up price advances would not materially increase incomes for several months, while in all probability they would stimulate demands for increased wages. As there is no influence remotely tending toward the lowering of prices, the general price level could hardly be more effectively stabilized than it is at this time.

REAL CONSUMPTIVE DEMAND NOT KNOWN

An unfortunate feature of the stimulus given to demand by the fear that production would be reduced is that the market as it is seen does not necessarily reflect the real consumptive demand. It is not known that buyers are really in position to consume all the steel they have been clamoring for. It is to be noted on the other hand that as a rule steel demand is light during the two midsummer months, and particularly toward the latter part of August, when the advent of Autumn is so near at hand that there is an unusual disposition to postpone purchases. The two influences may have pulled in opposite directions, and the more settled labor conditions that may now be expected with a considerable degree of confidence may not have the effect of decreasing the pressure of any buyers for deliveries.

While prospects as to the production of iron and steel may be regarded as greatly improved by the strong call of the President for a truce in the matter of labor demands, the iron and steel industry still has a difficulty arising from labor conditions, that difficulty being that the consumption or employment of steel in construction work is discouraged by the high cost of erection due to high wages and indifferent performance of labor. Much construction work that investors have in mind is not coming to a head because prospects as to cost of the work are not sufficiently well defined. The monthly reports of the Bridge Builders' and Structural Society have shown steady improvement in the volume of fabricated steel contracts let, such lettings representing 24½ per cent of the fabricating capacity in April, 49 per cent in May, 65 per cent in June and 74 per cent in July, but it is not certain that August will be found to have shown much if any improvement, and to give this branch of the industry a proper start after the war there should have been lettings for a few months at far beyond the capacity.

AUGUST STEEL PRODUCTION ABOUT 80 PER CENT

Production of steel in August, in terms of ingots, was probably between 75 and 80 per cent of capacity, but even with various curtailments due to strikes, particularly of railroad shopmen, the average percentage of capacity that was in operation was well above 80 per cent. The productive units in employment did not yield their normal tonnages, partly on account of the weather and partly on account of labor efficiency being well below par at many if not at all plants.

As some men are to be loved for the enemies they have made, the demand for iron and steel must be admired through its being as it is when the basis of demand is lacking in so many respects. It is remarkable that the industry can produce at more than 75 per cent of capacity when there is such a small quantity of steel passing into large construction jobs and when practically no steel at all is passing to the railroads. Just before the war ended the common appraisal was that since steel productive capacity had increased by 40 per cent since 1914 it would require the fullest co-operation of all lines of steel consumption, combined with a very large export demand, to produce requirements that would represent the productive capacity. The buyers absent from the market represent much more than the amount by which production falls short of capacity.

The Chemical Market

New York, August 26, 1919.

The usual seasonal lull has settled on the local market. Quiet is the word which characterizes conditions in vegetable oil, wax and naval stores circles. Dealers in the first two commodities, particularly, are taking it easy until September has run its length and active interest is once more resumed. In contrast, trading in heavy chemicals is fairly brisk, although not so satisfactory as two weeks ago, while business in coal-tar products was never better.

Export business is practically at a standstill, owing to the unfortunate status of foreign exchange. Quantities of merchandise are stored in New York undelivered because sellers would rather hold their goods than execute orders and suffer the heavy losses resulting from the disparity in exchange values.

HEAVY CHEMICALS

Interest in *sodium bichromate* has abated somewhat, bringing a slight reduction in price. The quotation at this writing ranges from 14c.-15c. per lb., while 15c.-16c. was a fair price two weeks ago. England, France, Denmark and Spain have been the foreign buyers of this product.

Potassium chlorate is receiving few sales at 18c.-19c. per lb. Recent arrivals of *Alsatian potashes*, together with the rumor that Germany is soon to send a like shipment, has contributed to this slackness.

Since the last review a fairly strong demand for *bleaching powder* (calcium hypochlorite) has developed, with South America the leading buyer, although domestic textile mills have bought in fair volume.

That *glacial acetic* acid has been in strong request for South America, England and France, as well as for domestic use, is attested to by the fact that delivery on this acid is not to be obtained under three or four weeks at August 15 quotations.

Muriatic (hydrochloric) is the only other acid offering particular interest. Heavy demand from Cuban sugar interests with a large domestic call has led to the boosting of the price in some quarters from \$1-\$1.50 per cwt. to \$1.75-\$2 for carlot quantities.

Although there is some talk of raising the export price on *caustic soda*, which was placed at \$3.50 per cwt. f.a.s. less 5 per cent by the U. S. Alkali Export Association, offerings are still being made of \$3.30-\$3.40 per cwt. f.a.s.

Alcohol is one of the few items which has increased in market value in the past two weeks. The large quantities of ethyl alcohol being exported, the high cost of wood alcohol and a general scarcity of goods are the reasons advanced for the increase. Methyl (wood, 95 per cent pure) is quoted at \$1.30 per gal. in carlots, an advance of 10c.; pure methyl at \$1.60; denatured, 188 proof, at 52c., and 190 proof at 46c.-48c. per gal.

COAL TAR PRODUCTS

The entire line is booming. During last week, in particular, a heavy volume of business was transacted, the buying coming not alone from dyestuffs and textile manufacturers, but from all classes of trade, such as rubber, paint and polish manufacturers.

Demand is strongest for aniline oil, salicylic acid, aniline salts, dimethylaniline and paranitraniline, the first two being very scarce.

In the words of one manufacturer, "Consumers are begging for aniline oil, but everyone has sold out his supply, as he has that of salicylic acid."

Along with the more refined coal tar products, crudes are participating in the increased activity, with toluol and benzol making their importance felt by an increase in price. The new price of benzol, pure waterwhite, is 25c. per gal. in carlots, the less carlot price ranging from 26c.-29c.; the 90 per cent variety, 24c. in carlots; whereas 24c., 25c.-28c., and 23½c., respectively, were the previous quotations. From 24c. per gal, in tank cars, toluol has jumped to 26c.

OILS

As in almost everything else, the foreign exchange situation has checked foreign business. On the other hand, there seems to be a tendency on the part of dealers to give less attention to export trade. Since November, 1918, a million barrels of vegetable and animal oils (the entire surplus) have been shipped abroad, leaving just sufficient to meet the normal domestic demand. In view of this condition, prices are expected to remain unchanged for some time.

The linseed oil market is in a slightly easier position than it was two weeks ago. Demand is less urgent, with prices holding unchanged at \$2.22 per gal. in carlots.

NAVAL STORES

Having gone as low at \$1.63 per gal., in the last two weeks, spirits of turpentine has returned to \$1.75. Scarcity of spot supplies is bulling the market.

Although rosins have dropped, due to the low rate of exchange and decreased demand, the market during the past few days has stiffened and appears likely to hold firm at the new prices, according to which W.W. is bringing \$24.75-\$25.00 and E \$18.50, in comparison with \$24.75-\$25.50 and \$19-\$19.50, respectively.

Among the flotation oils, the present price on pine oil, steam distilled, varies from the last quotation of 95c. per gal. by 10c.

St. Louis, August 22, 1919.

The strong demand for *nitric acid* has provided the feature of the local heavy chemical market in trading of the last two weeks. Producers are somewhat at a loss to account for the sudden interest in this acid, but believe that manufacturers of nitroglycerine are taking the bulk of their output.

Continued heavy demand for *60 deg. sulphuric* has resulted in a tax on the capacity of local producers. The price remains around \$12. Despite slackness in local steel manufacture, demand for 66 deg. sulphuric is improving, as it is also for the 98 deg. Failure of Kansas City producers to fill some contracts on the 66 deg. has thrown the burden on St. Louis producers. The price still holds at \$18 for carlots.

Demand is strong for *muriatic acid*, although some difficulties are being experienced in shipping. The *18 deg.* is still selling at \$22 in tank car lots. *Sodium bisulphate* (*niter cake*) is in strong demand. As high as \$3 a ton (representing an advance of \$1) has been offered, but little is on the open market.

Nitric acid has broken records for demand in the last month. The activity is laid to the demands of the nitroglycerine manufacturers. The *40 deg. Baumé* is selling at 10 and 10½c. per lb., *38 deg.* at 9c. and *42 deg.* at 11c., all unchanged from the last report.

Zinc chloride is slack and quiet. Demand has fallen off but the price is holding at 4c. on the open market, 3¾c. on contract.

Zinc oxide is still strong and even bigger business is looked for in the fall by local producers. Prices remain at 8c. to 9c. per lb. in carload lots, and ½c. higher for smaller quantities.

Ammonium chrome alum is in extremely heavy demand. Within the last ninety days the price has gone from 13½c. to 16½c. per lb. All of it is being exported and is being used by foreign tanners.

Chicago, August 25, 1919.

An accurate summing up of trade conditions in Chicago during the past fortnight is contained in the phrase "no change," as compared with the preceding several weeks. There have been no price changes of note, no great activity in any particular line and no export business of unusual scope. This is undoubtedly due to the fact that prices are now on a fairly high level and a feeling that speculators have a hand in boosting the market to its present point, this being particularly the case in vegetable oils. No great activity can be anticipated until there is either a recession in prices or consumers become convinced that prices are on a firm basis. Present buying is based solely on actual current needs.

Heavy Chemicals—No changes of moment in any item are recorded. *Sodium bichromate*, after its rapid rise in July, is holding firm at about 15c. *Red* and *yellow potassium prussiate* are as yet very hard to get, 70c. and \$1.10, respectively, being asked for the small quantities available. Among the acids, previous quotations hold good. *Nitric* is holding firm at 10½c. for *40 deg. Baumé*, despite a rather poor demand.

Coal-Tar Products—*Salicylic acid* at 43c. seems high, but the price stays firm. No change is noted in *benzol* or *phenol*, and with demand good the entire line seems to be fixed for some time to come on the existing price basis.

Vegetable Oils—In spite of rapid and violent fluctuations on the grain exchanges, corn oil, under good demand, remains at 21c. for spot delivery. Linseed is still quoted in one to four-barrel lots to consumers at \$2.48, with 25c. off for large quantities. This seems high, but the fact that the entire production of the crushers is absorbed by the trade as rapidly as offered renders any decline unlikely. The Archer-Daniels Co., in its Minneapolis plant, is said to be crushing 10,000 bu. of flax every day.

Flotation Oils, Naval Stores—The steady increase of prices in these lines continues. Turpentine is now \$1.75, 0.933 test pure steam-distilled pine oil \$1.00 to \$1.05 and destructively distilled pine oil 90c. to 95c. The larger dealers report their entire visible supply of oils sold up to Dec. 1, and that they are not only refusing quotations to new customers but are short-filling orders from old ones. The cause of this famine condition is scant production during the past season and heavy export orders. During the recent harbor strike in New Orleans, 35,000 bbl. of pine oil, intended for export, accumulated on the docks in a few days. Such a severe drain on our already short supply can only produce a serious condition.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, AUG. 26, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	......–......	$0.54 – $0.60
Acetone	lb.	$0.13½ – 0.14	.15 – .15½
Acid, acetic, 28 per cent	cwt.	2.50 – 3.00	3.00 – 3.25
Acetic, 56 per cent	cwt.	5.50 – 6.00	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00 – 12.50	12.90 – 13.50
Boric, crystals	lb.	.13 – .13½	.13½ – .14
Boric, powder	lb.	.13 – .13½	.13½ – .14
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	1.00 – 1.50	1.75 – 2.50
Hydrofluoric, 52 deg	lb.	.10 –......	.11 –......
Lactic, 44 per cent. tech	lb.	.11 – .14	.12 – .16
Lactic, 22 per cent. tech	lb.	.05 – .06	.05½ – .07
Molybdic, C. P	lb.	......–......	4.50 – 5.50
Nitric, 40 deg	lb.	.06 – .06½	.07 – .08½
Nitric, 42 deg	lb.	.07 – .07½	.08 –......
Oxalic, crystals	lb.	.23 – .25	.25 – .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 –......	.10 – .14
Picric	lb.	.30 – .40	.50 –......
Pyrogallic, resublimed	lb.	......–......	2.30 – 2.45
Sulphuric, 60 deg., tank cars	ton	12.00 – 14.00	......–......
Sulphuric, 60 deg., drums	ton	17.00 –......	22.00 –......
Sulphuric, 60 deg., carboys	ton	20.00 –......	25.00 –......
Sulphuric, 66 deg., tank cars	ton	16.00 – 18.00	22.00 – 23.00
Sulphuric, 66 deg., drums	ton	20.00 – 21.00	25.00 – 26.00
Sulphuric, 66 deg., carboys	ton	25.00 –......	30.00 – 40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	22.00 –......	27.00 –......
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 –......	32.00 –......
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 –......	35.00 –......
Tannic, U. S. P	lb.	......–......	1.30 – 1.40
Tannic (tech.)	lb.	......–......	.42 – .55
Tartaric, crystals	lb.	......–......	.84 – .86
Tungstic, per lb. of WO	lb.	......–......	1.20 – 1.40
Alcohol, Ethyl	gal.	4.00 –......	4.85 –......
Alcohol, Methyl	gal.	1.30 –......	1.33 – 1.38
Alcohol, denatured, 188 proof	gal.	.52 –......	.54 – .55
Alcohol, denatured, 190 proof	gal.	.46 – .48	.50 – .51
Alum, ammonia lump	lb.	.03½ – .04½	.04½ – .04¾
Alum, potash lump	lb.	.08 – .09	.08½ – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01¾ – .02	.02¼ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03¼ – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 –......	.08 – .09
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	......–......	.30 – .35
Ammonium carbonate, powder	lb.	.13 – .13½	.14 – .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½ – .13	.13½ – .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 – .12½	.13 – .13½
Ammonium nitrate	lb.	.10 –......	.11 – .12
Ammonium sulphate	lb.	.05 –......	.06 –......
Amyl acetate	gal.	......–......	3.75 – 3.80
Arsenic, oxide, lumps	lb.	......–......	.09 – .09½
Arsenic, sulphide, powdered	lb.	......–......	......–......
Barium chloride	ton	75.00 – 80.00	85.00 –......
Barium dioxide (peroxide)	lb.	.22 –......	.24 –......
Barium nitrate	lb.	.10 – .10½	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.02½ – .03	.03½ – .04
Bleaching powder (see calcium hypochlorite)		......–......	......–......
Blue Vitriol (see copper sulphate)		......–......	......–......
Borax (see sodium borate)		......–......	......–......
Brimstone (see sulphur, roll)		......–......	......–......
Bromine	lb.	......–......	.65 – .75
Calcium acetate	cwt.	2.00 – 2.05	2.10 –......
Calcium carbide	lb.	......–......	.04 – .05
Calcium chloride, fused, lump	ton	19.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	1.75 – 1.80	2.00 – 2.50
Calcium peroxide	lb.	......–......	1.50 – 1.70
Calcium phosphate, monobasic	lb.	......–......	.75 –......
Calcium sulphate, precipitated	lb.	......–......	.09 – .09½
Carbon bisulphide	lb.	.05½ –	.06 – ....
Carbon tetrachloride, drums	lb.	.11 –......	.12 – .14
Carbonyl chloride (phosgene)	lb.	......–......	.75 –......
Caustic potash (see potassium hydroxide)		......–......	......–......
Caustic soda (see sodium hydroxide)		......–......	......–......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.08 –......
Cobalt oxide	lb.	......–......	1.60 – 1.65
Copperas (see iron sulphate)		......–......	......–......
Copper carbonate, green precipitate	lb.	......–......	.28 – .31
Copper cyanide	lb.	......–......	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .08¾	.09 – .09½
Cream of tartar (see potassium bitartrate)		......–......	......–......
Epsom salt (see magnesium sulphate)		......–......	......–......
Formaldehyde, 40 per cent	lb.	......–......	.19 – .21
Glauber's salt (see sodium sulphate)		......–......	......–......
Glycerine	lb.	......–......	.19 – .21
Iodine, resublimed	lb.	......–......	4.50 –......
Iron oxide, red	lb.	......–......	.03 – .20
Iron sulphate, (copperas)	cwt.	1.00 –......	1.20 – 1.50
Lead acetate, normal	lb.	......–......	.12½ – .14½
Lead arsenate (paste)	lb.	......–......	.13 – .17
Lead nitrate, crystals	lb.	......–......	.85 – .86½
Litharge	lb.	......–......	.09½ – .10½
Lithium Carbonate	lb.	......–......	1.50 –......
Magnesium carbonate, technical	lb.	......–......	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	2.00 – 2.63	2.75 –......
Magnesium sulphate, commercial	100 lb.	1.75 –......	2.00 – 2.50
Nickel salt, double	lb.	.14 –......	.15 –......
Nickel salt, single	lb.	.12 –......	.15 – .16
Phosgene (see carbonyl chloride)		......–......	......–......
Phosphorus, red	lb.	......–......	.65 – .70
Phosphorus, yellow	lb.	......–......	.35 – .37
Potassium bichromate	lb.	.25 – .28	......–......
Potassium bitartrate (cream of Tartar)	lb.	......–......	.55 – .60
Potassium bromide, granular	lb.	......–......	.49 – .50
Potassium carbonate, U. S. P.	lb.	.60 –......	.65 – .70
Potassium carbonate, crude	lb.	.17 –......	.20 –......
Potassium chlorate, crystals	lb.	.20 – .24	.25 – .30
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.30 – .32	.35 – .40
Potassium iodide	lb.	......–......	3.55 – 3.60
Potassium nitrate	lb.	.19 –......	.21 –......
Potassium permanganate	lb.	......–......	.55 – .65
Potassium prussiate, red	lb.	......–......	.90 – 1.10
Potassium prussiate, yellow	lb.	......–......	.50 – .60
Potassium sulphate	ton	225.00 –......	......–......
Rochelle salts (see sodium potas. tartrate)		......–......	......–......
Salammoniac (see ammonium chloride)		......–......	......–......
Sal soda (see sodium carbonate)		......–......	......–......
Salt cake (sodium sulphate)	ton	17.00 – 18.00	......–......
Silver cyanide	oz.	......–......	1.19 –......
Silver nitrate	oz.	......–......	.67½ – .68½
Soda ash, light	100 lb.	1.85 – 1.90	2.00 –......
Soda ash, dense	100 lb.	2.25 –......	2.50 –......
Sodium acetate	lb.	.06 – .07	.07 – .08
Sodium bicarbonate	100 lb.	2.35 –......	2.75 – 3.00
Sodium bichromate	lb.	.14½ –......	.15 – .16
Sodium bisulphate (nitre cake)	ton	3.00 – 8.00	10.00 –......
Sodium bisulphite	cwt.	1.80 – 1.90	2.00 – 2.10
Sodium borate (borax)	lb.	.07½ –......	.08 –......
Sodium carbonate (sal soda)	100 lb.	1.35 – 1.50	1.50 – 1.75
Sodium chlorate	lb.	.15 –......	.16 – .18½
Sodium cyanide	lb.	.30 –......	.31 – .34
Sodium fluoride	lb.	.13 –......	.14 – .15
Sodium hydroxide (caustic soda)	100 lb.	2.75 –......	2.90 – 3.50
Sodium molybdate	lb.	2.50 –......	3.25 –......
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.09½ – .10	.10½ – .13
Sodium peroxide, powdered	lb.	......–......	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04 – .05
Sodium potassium tartrate (Rochelle salts)	lb.	......–......	43 – .45½
Sodium prussiate, yellow	lb.	.17½ – .18½	.19 – .20
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ –......	......– .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.05 – 1.35	1.50 – 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	......–......	.05 – .06
Sodium sulphite, crystals	lb.	.03½ –......	.04 –......
Strontium nitrate, crystals	lb.	.25 –......	......– .28
Sulphur chloride	lb.	.05½ –......	......– .06
Sulphur, crude	ton	22.00 –......	......–......
Sulphur dioxide, liquid, cylinders	lb.	......–......	.10 – .12
Sulphur (sublimed), flowers	100 lb.	3.00 – 3.05	......– 3.60
Sulphur, roll (brimstone)	100 lb.	2.70 – 3.00	3.65 –......
Tin bichloride (stannous)	lb.	.48 –......	.49 – .50
Tin oxide	lb.	......–......	.60 –......
Zinc carbonate, precipitate	lb.	......–......	.20 –......
Zinc chloride, gran.	lb.	.12½ –......	.13½ – .14
Zinc cyanide	lb.	.49 –......	.50 –......
Zinc dust	lb.	.09 – .11	.11 – .14
Zinc oxide, dry American	lb.	......–......	.10 – .13
Zinc sulphate	lb.	.03½ –......	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00 — $1.10
Alpha naphthol, refined	lb.	1.40 — 1.50
Alpha naphthylamine	lb.	.35 — .50
Aniline oil, drums extra	lb.	.26 — .30
Aniline salts	lb.	.28 — .33
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	1.00 — 1.15
Benzidine, base	lb.	1.00 — 1.25
Benzidine, sulphate	lb.	1.00 — 1.15
Benzoic acid, U. S. P.	lb.	1.00 — 1.10
Benzoate of soda, U. S. P.	lb.	.95 — 1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.25 — .29
Benzol, 90%, in drums (100 lb.)	gal.	.24 — .28
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta naphthol benzoate	lb.	3.75 — 4.50
Beta naphthol, sublimed	lb.	.75 — .80
Beta naphthol, tech	lb.	.45 — .55
Beta naphthylamine, sublimed	lb.	2.25 — 2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 — .....
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85 — .90
Cresylic acid, 95-97%, dark, in drums	gal.	.80 — .85
Cresylic acid, 50%, first quality, drums	gal.	.60 — .....
Dichlorbenzol	lb.	.07 — .10
Diethylaniline	lb.	1.40 — 2.25
Dimethylaniline	lb.	.50 — .57
Dinitrobenzol	lb.	.25 — .37
Dinitroclorbenzol	lb.	.25 — .30
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	.33 — .36
Dinitrotoluol	lb.	.38 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.65 — .....
Diphenylamine	lb.	.58 — .75
H-acid	lb.	1.75 — 2.25
Metaphenylenediamine	lb.	1.20 — 1.80
Monochlorbenzol	lb.	.12 — .15
Monoethylaniline	lb.	1.50 — 1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06 — .08
Naphthaline, flake	lb.	.06½ — .07½
Naphthaline, balls	lb.	.08½ — .10
Naphthionic acid, crude	lb.	.75 — 1.25
Nitrobenzol	lb.	.13 — .19
Nitro-naphthaline	lb.	.35 — .45
Nitro-toluol	lb.	.17 — .20
Ortho-amidophenol	lb.	4.25 — .....
Ortho-dichlor-benzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.90 — 1.00
Ortho-nitro-toluol	lb.	.27 — .40
Ortho-toluidine	lb.	.30 — .45
Para-amidophenol, base	lb.	2.60 — 3.50
Para-amidophenol, HCl	lb.	2.75 — 3.25
Para-dichlor-benzol	lb.	.06 — .10
Paranitraniline	lb.	1.05 — 1.25
Para-nitro-toluol	lb.	1.35 — 1.50
Paraphenylenediamine	lb.	2.75 — 4.00
Paratoluidine	lb.	1.50 — 2.50
Phthalic anhydride	lb.	1.75 — 2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10 — .13
Pyridin	gal.	2.50 — .....
Resorcin, technical	lb.	3.50 — 3.75
Resorcin, pure	lb.	6.50 — 7.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.35 — .40
Salicylic acid, U. S. P.	lb.	.40 — .45
Salol	lb.	.80 — .90
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.22 — .27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 — .24
Sulphanilic acid, crude	lb.	.23 — .38

Tolidine	lb.	$1.75 — $2.50
Toluidine, mixed	lb.	.45 — .80
Toluol, in tank cars	gal.	.26 — .....
Toluol, in drums	gal.	.30 — .....
Xylidine, drums, 100 gal	lb.	.44 — .50
Xylol, pure, in drums	gal.	.37 — .45
Xylol, pure, in tank cars	gal.	.35 — .....
Xylol, commercial, in drums, 100 gal	gal.	.23 — .27
Xylol, commercial, in tank cars	gal.	.22 — .....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.41 — $0.45
Beeswax, refined, yellow	lb.	.48 — .49
Beeswax, white pure	lb.	.65 — .68
Carnauba, No. 1	lb.	.88 — .90
Carnauba, No. 2, regular	lb.	.65 — .80
Carnauba, No. 3, North Country	lb.	.55 — .60
Japan	lb.	.18½ — .20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06 — .....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.06 — .06½
Paraffine waxes, refined, 118-120 m.p	lb.	.07½ — .08
Paraffine waxes, refined, 128-130 m.p	lb.	.08½ — .09
Paraffine waxes, refined, 133-135 m.p	lb.	.10½ — .11
Paraffine waxes, refined, 135-137 m.p	lb.	.12 — .13½
Stearic acid, single pressed	lb.	.23 — .26
Stearic acid, double pressed	lb.	.27 — .28
Stearic acid, triple pressed	lb.	.30 — .33

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr.. 0.930-0.940	gal.	$1.05
Pine oil, pure, dest. dist.	gal.	85
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.34
Turpentine, crude, sp. gr., 0.900-0.970	gal	.85
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.27
Pinewood creosote, ref	gal.	.48

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$16.80 — $18.25
Rosin F-I	280 lb.	18.50 — 20.25
Rosin K-N	280 lb.	21.00 — 24.00
Rosin W. G.-W W	280 lb.	24.50 — 25.00
Wood rosin, bbl	280 lb.	17.00 — 18.00
Spirits of turpentine	gal.	1.75 — .....
Wood turpentine, steam dist	gal.	1.68 — .....
Wood turpentine, dest. dist	gal.	1.55 — .....
Pine tar pitch, bbl	200 lb.	8.25 — 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	12.75 — 13.50
Retort tar, bbl	280 lb.	13.75 — 14.50
Rosin oil, first run	gal.	.86 — .91
Rosin oil, second run	gal.	.88 — .93
Rosin oil, third run	gal.	.90 — 1.07
Rosin oil, fourth run	gal.	.93 — 1.10

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.54½ — $0.55½
Upriver coarse	lb.	.31½ — .....
Upriver caucho ball	lb.	.31 — .32
Plantation—First latex crepe	lb.	.44 — .45
Ribbed smoked sheets	lb.	.43 — .43½
Brown crepe, thin, clean	lb.	.38 — .....
Amber crepe No. 1	lb.	.40½ — .41

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.19 — $0.20
Castor oil, AA, in bbls	lb.	.21 — .22
China wood oil, in bbls	lb.	.22 — .24
Cocoanut oil, Ceylon grade, in bbls	lb.	.19 — .20
Cocoanut oil, Cochin grade, in bbls	lb.	.21 — .22
Corn oil, crude, in bbls	lb.	.24 — .25
Cottonseed oil, crude (f.o.b. mill)	lb.	.28 — .29
Cottonseed oil, summer yellow	lb.	.26 — .29
Cottonseed oil, winter yellow	lb.	.27½ — .30
Linseed oil, raw, car lots	gal.	2.17 — 2.22
Linseed oil, raw, tank cars	gal.	2.17 — 2.19
Linseed oil, boiled, car lots	gal.	2.25 — 2.30
Olive oil, commercial	gal.	2.30 — 2.50
Palm, Lagos	lb.	.17 — .18½
Palm, bright red	lb.	16½ — .17½
Palm, Niger	lb.	.16½ — .17½
Peanut oil, crude, tank cars (f.o.b mill)	lb.	.24 — .27
Peanut oil, refined, in bbls	lb.	.29 — .30
Rapeseed oil, refined in bbls	gal.	1.50 — 1.60
Rapeseed oil, blown, in bbls	gal.	1.60 — 1.70
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.18½ — .20
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½ — .17

FISH

Winter pressed Menhaden	gal.	$1.28 — $1.35
Yellow bleached Menhaden	gal.	1.30 — 1.37
White bleached Menhaden	gal.	1.32 — 1.38
Blown Menhaden	gal.	1.38 — 1.40

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00 — $36.00
Barytes, off color	ton	20.00 — 25.00
Blanc fixe, dry	lb.	.03½ — .04½
Blanc fixe, pulp	ton	35.00 — 47.50
Casein	lb.	.16 — .18
Chalk, English, extra light	lb.	.05 — .07
Chalk, English, light	lb.	.04½ — .06
Chalk, English, dense	lb.	$ .04 — $ .05
China clay (Kaolin), imported, lump	ton	25.00 — 35.00
China clay (Kaolin), imported, powdered	ton	30.00 — 60.00
China clay (Kaolin), domestic, lump	ton	10.00 — 20.00
China clay (Kaolin), domestic, powdered	ton	25.00 — 40.00
Feldspar	ton	11.50 — 16.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	$30.00 — $35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00 — 45.00
Fuller's earth, domestic, powdered	ton	30.00 — 40.00
Fuller's earth, imported, powdered	ton	.... — .....
Pumice stone, imported	lb.	.03 — .06
Pumice stone, domestic	lb.	.02½ — .....
Shellac, TN	lb.	1.20 — .....
Shellac, D. C	lb.	..... — .....
Shellac, V. S. O	lb.	..... — .....
Shellac, Diamond I	lb.	..... — .....
Shellac, orange, fine	lb.	..... — .....
Shellac, orange, superfine	lb.	1.35 — .....
Shellac, A.C. garnet	lb	.95 — .....
Shellac, bleached, bone dry	lb.	1.40 — .....
Shellac, bleached, fresh ground	lb.	1.10 — .....
Soapstone	ton	15.00 — 25.00
Talc, domestic	ton	16.00 — 60.00
Talc, imported	ton	55.00 — 60.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	net ton	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.30 — .40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70 — .....
Ferro-manganese, 70-80% Mn	gross ton	100.00 — 125.00
Spiegeleisen, 16-20% Mn	gross ton	35.00 — 50.00
Ferro-molydenum, per lb. of Mo	lb.	1.85 — 2.00
Ferro-silicon, 50%	gross ton	85.00 — 115.00
Ferro-silicon, 75%	gross ton	150.00 — 175.00
Ferro-silicon, 10-15%	gross ton	45.00 — 60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.30 — 1.60
Ferro-uranium, 35-50%, of U	lb.	7.00 — .....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50 — 7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, $C_2.O_3$	unit	$0.60 —
Chrome ore, 48% and over	unit	.80 —
Coke, foundry, f.o.b. ovens	net ton	5.50 — $6.00
Coke, furnace, f.o.b. ovens	net ton	4.00 — 5.00
Petroleum coke, refinery, Atlantic seaboard	net ton	11.50 — 12.00
Fluorspar, gravel, f.o.b. mines	net ton	20.00 — 25.00
Manganese ore, 45% Mn and over	unit	.50 — .65
Manganese ore, chemical (MnO_2)	gross ton	60.00 — 70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75 — .85
Tungsten, Scheelite, 60% WO_3 and over per unit of WO_3	unit	9.00 — 12.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.00 — 10.00
Uranium oxide, 96%	lb.	..... — .....
Vanadium pentoxide, 99%	lb.	6.00 — .....
Pyrites, foreign, lump	unit	.15 — .....
Pyrites, foreign, fine	unit	.15 — .....
Pyrites, domestic, fine	unit	.14 — .17½
Ilmenite, 52% TiO_2, f.o.b. N. Y.	net ton	38.15 — .....
Rutile, 95% TiO_2, f.o.b. N. Y.	net ton	200.00 — .....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75 — 3.00
Zircon, washed, iron free, f.o.b. N. Y.	net ton	125.00 — .....
Monazite, per unit of ThO_2, f.o.b. N. Y.	unit	42.00 — .....

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	15.00
Yellow pine, 3x4 to 8x8, 20-24 ft. long	M.	40.00
Yellow pine, 3x4 to 8x8, 20-24 ft. long at Chicago	M.	39.50
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis	M.	37.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	60.00
Roofings, tar pitch (in 400-lb. bbl.)	ton	21.00
Roofings, asphalt pitch	ton	34.00
Roofings, asphalt felt	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft.		2.00
Roofings, slate-finished shingles, 100 sq.ft.		5.00
Linseed oil, raw in barrels	gal.	2.25
Linseed oil, 5 gal. cans	gal.	2.40
Red lead, dry, 100 lb. keg	lb.	13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

WARREN—The Phelps Dodge Corporation, Douglas, plans to build a concentration plant at copper mines. H. K. Burch, c/o owner, engineer.

California

HUNTINGTON PARK—The Southern California Iron & Steel Co., 417 Mateo St., Los Angeles, plans to build an iron and steel fabricating plant consisting of about 8 buildings to include an open-hearth mill, nut, rivet, forge and machine shop and galvanizing building, etc. Estimated cost, $1,750,000.

PITTSBURGH—The Columbia Steel Co., 503 Market St., San Francisco, will erect a steel and corrugated iron rolling plant. Estimated cost, $250,000. Work will be done by day labor.

TORRANCE—The Torrance Window Glass Co. plans to rebuild the glass factory, consisting of several frame, galvanized iron and brick buildings which were recently destroyed by fire. Estimated cost, $25,000.

Connecticut

BRIDGEPORT—The Bridgeport Brass Co., Grand St., soon lets contract for the construction of a 1-story, 150 x 226-ft. addition to its casting shop. Estimated cost, $150 000. The H M. Lane Co., 701 Owen Bldg., Detroit, Mich., engineer.

GLENBROOK—C. A. Phillips Chemical Co. has awarded the contract for the construction of a 2-story factory, to Thompson & Brager, 283 Madison Ave., New York City. Estimated cost, $55,000.

MYSTIC—The Packer Tar Soap Co., Lincoln Ave., plans to build additions to plant, to include a 1-story storage building, 1-story factory and a 25 x 30-ft. power house. Estimated cost. $40 000 Bilderbeck & Langdon, Inc., Barrows Bldg., New London, engineer.

WINDSOR LOCKS—C. H. Dexter & Son, Inc., will soon award the contract for the construction of a 5-story, 55 x 100-ft. paper mill addition. Estimated cost, $100 000. Greenwood & Noerr, 847 Main St., Hartford, engineer.

Delaware

NEWARK—The Continental Fibre Co. has awarded the contract for the construction of a 2-story, 60 x 240-ft factory to the Austin Co., Bulletin Bldg., Philadelphia. Estimated cost, $56,000.

YORK LYN—The National Fibre Insulation Co. has awarded the contract for the construction of a 2-story, 60 x 140-ft. factory, to the Austin Co., Bulletin Bldg., Philadelphia. Estimated cost, $40,000.

Idaho

CŒUR D'ALENE—The Home Builder Mine & Milling Co. plans to build the first unit of nitrate plant on the shore of the Cœur d'Alene Lake. Estimated cost, $50,-000. W. C. Brower, Spokane, Wash., metallurgical chemist.

LEONA—The Idaho Lead & Copper Co., 507 Eagle Block, Spokane, Wash., plans to build 1600 ft. of underground workings and will install a 50-ton mill and compressor. Estimated cost, $40,000. E. J. Merrin, president.

Illinois

SALEM—The city has awarded the contract for the construction of a reinforced concrete, brick and steel water filtration plant here, to W. C. Johnson Construction Co., South High St., Belleville. Total estimated cost, $12,000.

Iowa

CLARINDA—The city has awarded the contract for the installation of 2,500,000 gal. rapid sand filters, to the Pittsburg Filter Manufacturing Co., c/o E. W. Bacharach, Western manager, 429 Rialto Bldg., Kansas City, Mo. Estimated cost, $11,000.

CORNING—The city will soon award the contract for sewer improvement and a disposal plant. Estimated cost, $40 000. Archer & Stevens, 609 New England Bldg., Kansas City, Mo., engineer.

DEXTER—The city plans to build a sewer system and sewage disposal plant involving 1030 cu.yd. filter sand and 82 cu.yd. of filter gravel. H. H. Hough, city clerk.

INWOOD—The city will soon award the contract for the construction of a complete sewer system and sewage disposal plant. C. H. Currie. Webster City, engineer.

POCAHONTAS—The city will soon award the contract for the construction of a complete sewer system and sewage disposal plant. C. H. Currie, Webster City, engineer. Noted June 1.

Kansas

BLUE MOUND—The Vinegar Hill Zinc Co., Baxter Springs, plans to install a flotation machine, and is changing entire mill from gas to electric power at its Barr mine here. Is in market for motors and transformers. J. G. Trewartha, superintendent.

TREECE—Waugh & Jones Co., Baxter Springs, has recently taken over the old De Armand mill and plans to enlarge table room and change from steam to gas power. Is in the market for 5 tables, 1 set rolls and 3 gas engines. W. Waugh, manager.

WICHITA—The Sinclair Refining Co. plans to construct an oil distributing plant, to consist of several buildings. Estimated cost. $150,000. C. W. Birdsall, c/o owner, architect.

Maryland

BALTIMORE—Sherwood Bros., Bank and 8th Sts., plans to construct a 2-story, 75 x 200-ft. oil refinery and warehouse. Estimated cost, $100,000.

HAGERSTOWN—The Green Mining Co., 7 East Washington St., plans development green stone quarry near here and will install 100-ton daily capacity mill. A. Ludwig, manager.

Massachusetts

EAST SPRINGFIELD—The Atlantic Refining Co., 503 Turks Head Bldg., Providence, R. I., has awarded the contract for the construction of a 2-story oil plant on Page Blvd. and Robbins Rd., to Metzger & Fisher Co., Otis Bldg., Philadelphia. Estimated cost, $50,000.

Michigan

DETROIT—The Detroit Soluble Oil Co., Beard St. and Michigan Central Railroad, has purchased site on Dix Ave. and plans to erect a factory for cutting oil, there. Architect not selected.

HIGHLAND PARK (Detroit P. O.)—The Maxwell Motor Co., Oakland Ave., will receive bids until Sept. 7 for the construction of a 1-story, 315 x 557-ft. pressed steel plant at Oakland and Massachusetts Aves. Stamping equipment, consisting of presses, rolls and furnishing tanks, will be installed. Smith, Hinchman & Grylls, Washington Arcade, Detroit, architects.

ROYAL OAK (Vinsetta Park Subdivision)—M. L. Brown & Son, engineer, 821 Chamber of Commerce Bldg., Detroit, will receive bids for furnishing labor and material for complete sewer system and disposal works, to include an 8 x 10-ft. vitrified crock, Imhoff tank, ejector station and sprinkling filter system, for the Vinsetta Land Co. Estimated cost, $25,000.

Minnesota

ST. PAUL—The St. Paul Welding Co., 173 West 3rd St., is having plans prepared for the construction of a 2-story, 36 x 75-ft. welding shop. Estimated cost, $115,000. M. A. Wright, Pittsburgh Bldg., St. Paul, architect.

Missouri

HOLDEN—The city has awarded the contract for the construction of a sanitary sewer system and disposal plant, to J. O'Neil Leavenworth, Kan. Estimated cost, $57,000.

LIBERTY—The William Jewell College plans to construct a new college to include a science department. Laboratory equipment will be installed in same. Estimated cost, $200,000.

MARYVILLE—The city is receiving bids for the construction of 2 reservoirs, reinforced coagulating plant, etc. Estimated cost, $35,000. F. E. Harper, 2408 East 30th St., Kansas City, engineer.

MARYSVILLE—A. D. Hewett, city clerk, will soon receive bids for the construction of a water filtration plant. Estimated cost, $50,000.

MILAN—The city has awarded the contract for the construction of a sanitary sewer, including disposal plant, to J. O'Neil Leavenworth, Kan. Estimated cost, $29 000. Noted Aug. 15.

ST LOUIS—The Mississippi Valley Iron Co., 6500 South Broadway, has awarded the contract for the construction of a 1-story, 29 x 82-ft. engine house, and a 36 x 93-ft. gas producing factory, to the Fruin-Colnon Construction Co., Merchants Laclede Bldg. Estimated cost, $32,000.

ST. LOUIS—The Parker Russell Mining & Manufacturing Co., Laclede Gas Bldg., has awarded the contract for the construction of a 2-story, 98 x 129-ft. silica factory, to J C. Settle & Co., Pontiac Bldg Estimated cost, $20,000. Noted May 15.

Montana

SCOBEY—The city council has awarded the contract for the construction of a sewer system, to include manholes, settling tank and sludge beds, to G W. Kemper, Minot, N. Dak. Estimated cost, $49,485. Noted Aug. 15.

LIBBY—The Lukens Hazel Mining Co. plans to build a 200-ton concentration plant and to increase power plant and develop 600-hp. system by installing pipe line from Granite Creek to Lukens Hazel Mine. Also plans to install compressor, jigs, tables and flotation machines. Estimated cost. $240,-000. Oscar Nordquist, superintendent.

New Jersey

NEWARK—The American Platinum Works, New Jersey Railroad Ave., has awarded the contract for the construction of a 3-story, 50 x 130-ft. reinforced concrete building, to Fred Kilgus, Inc., 13 Sixth St. Estimated cost, $100,000.

ORANGE—The Board of Freeholders of Essex County, Newark, received low bid for the construction of a sewer disposal plant for sanatorium in Orange Mts., from Averill Mahlon Construction Co., 31 Clinton St., $90,000.

New York

ALBANY—Charles F. Rattigan, superintendent of prisons, will receive bids Sept. 4 for the construction of a concrete dam, cast iron pipe line and mechanical gravity filter plant at Wingdale Prison, Wingdale, N. Y.

BROOKLYN—The E. A. Laboratory, Inc., 80 Broadway, has awarded the contract for the construction of a 2-story, 100 x 100-ft. factory, at Spencer St. and Myrtle Ave., to Barney-Ahlers Construction Co., 110 West 40th St., New York City. Estimated cost, $95,000. B. Driesler, 153 Remsen St., architect.

MIDDLETOWN—The Middletown State Homeopathic Hospital Commission received bids Aug. 20 for furnishing all labor and material complete for the construction work of mortuary and laboratory, from Giles Construction Co., $21,062, and A. E. Stephens Co., Springfield, Mass., $28,800.

North Carolina

RUTHERFORDTON—The city has awarded the contract for the construction of a filtration plant in connection with the proposed waterworks system, to the Norwood Engineering Co., Rutherfordton.

STATESVILLE—The city will receive bids Sept. 16 for the construction of a concrete filter plant, 1,000 000-gal. capacity. Former bids were rejected. R. L. Greenlee, Raleigh, engineer.

Ohio

CLEVELAND—The Cuyahoga Galvanizing Co., 1280 East 59th St., has awarded the contract for the construction of a 1-

story, 60 x 100-ft. factory on 3352 Payne Ave., to G. R. Atkin, 9212 Hough Ave. Estimated cost, $10,000. Noted Aug. 15.

CLEVELAND—The Enamel Products Co., 341 Eddy Rd., plans to build a 2-story, 180 x 40-ft. addition to factory. Estimated cost, $10,000.

CLEVELAND—The Standard Brass & Foundry Co., 990 East 67th St., is receiving bids for the construction of a 2-story, 38 x 59-ft. office building and shop. Estimated cost, $10,000.

CLEVELAND—The Ohio Carbon Co., 3620 Lorain Ave., has awarded the contract for the construction of a 1-story, 51 x 100-ft. factory on 8219 Almira Ave., to Uhl & Jasper Co., 1900 Euclid Ave. Estimated cost, $15,000.

COLUMBUS—The Tinker Roller Bearing Co., Dueber Ave., Canton, has awarded the contract for the construction of a 1-story, 282 x 482-ft. factory, at 5th and Cleveland Aves., to D. W. McGrath, New First National Bldg. Estimated cost, $550,000.

DOVER—The Tuscora Rubber Co. is receiving bids for the construction of a 3-story, 200 x 300-ft. rubber factory here. Estimated cost, $300,000. W. C. Owen Co., 1900 Euclid Ave., architect.

Oklahoma

COLLINSVILLE—The city plans election Sept. 3 to vote on $40,000 bond issue for the construction of a water purification plant—filters, settling basins, etc. Johnson & Benham, Firestone Bldg., Kansas City, Mo., engineer.

ENID—The city voted $500,000 bonds for improving water system, extending sewers and building disposal plant. Black & Veach, Interstate Bldg., Kansas City, Mo., engineer. Noted July 1.

IDABEL—The city has awarded the contract for the construction of sanitary sewers and sewage disposal plant, to include 2 Imhoff tanks with contact beds and filters, to the Empire Construction Co., Kansas City, Mo. Estimated cost, $119,800. Noted Aug. 1.

SUNNYSIDE (McLeod P. O.)—The West Virginia Mining Co., Baxter Springs. Kan., plans to construct a mill and is in the market for entire equipment for same. J. Hatton, superintendent.

Oregon

BEND—The Oregon Nitrate Co. plans to develop Stinking Lake and Sheep Mountain nitrate deposits by installing crystallization evaporation system and crushing plant. Estimated cost, $25,000. J. H. Morgan. Bend, president.

SUMMER LAKE—J. Moore plans to erect a 1-story soda ash and potash plant here, capacity 10,000 tons. Estimated cost, $190,000.

Pennsylvania

MORRISVILLE—The city plans to build a sewage system and disposal plant. Estimated cost, $265,000. T. E. Bowe, East Rutherford, N. J., engineer.

PHILADELPHIA—The General Manufacturing Co., Delaware and Bigler Aves., has awarded the contract for the construction of a 3-story, 100 x 300-ft. factory and storage building, to H. P. Friend, Inc., Arcade Bldg., Boyer St., Norristown.

Texas

SAN ANTONIO—The Bear Rubber Mills, Ltd., plans to construct a 1-story, 300 x 360-ft. factory on Frio City Rd. Estimated cost, $200,000. Gulick, Hoff & Ries, 309 Frost Bldg., engineers.

Virginia

BERRYVILLE—The town is having plans prepared for the construction of a new water filtration plant by Gannett, Seelye & Fleming, Harrisburg, Pa., engineers.

ORANGE—The town voted $70,000 bonds for improving waterworks system, including filter plant, pumping equipment and force main. A. J. Harlow, mayor.

SUFFOLK—The Eastern Oil Co. plans to build plant for the manufacture of cottonseed and peanut oils, daily capacity 75,000 tons. Estimated cost, $125,000.

Wisconsin

BEAVER DAM—The Malleable Iron Range Co. has awarded the contract for the construction of a 2-story foundry addition, including an annealing department, to the Hutter Construction Co., Fond du Lac. About $30,000.

CUBA CITY—The Connecting Link Manufacturing Co. plans to erect two jig mills and install machinery assembled last fall in the zinc and lead mine 4½ miles northeast of here. Estimated cost, $24,000. Theodore Waech, superintendent.

JANESVILLE—The Samson Tractor Co., Division of the General Motors Corporation, 88 East Congress St., Detroit, Mich., is building a plant to include a gray iron foundry, core room, sand storage building and pattern shop, to cover an area of 330 x 530 ft. Estimated cost, $1,000,000. Frank D. Chase, Inc., 645 North Michigan Ave., Chicago.

KOHLER—The Kohler Co., c/o W. J. Kohler, will soon award the contract for the construction of a 4-story, 180 x 260-ft. enamel ware factory, on Elm St. Estimated cost, $40,000. Brust & Phillip, Free Press Bldg., Milwaukee, architect.

LINDEN—Piquette & Altenberg, Platteville, plan to erect a mill and install machinery in the zinc mine here. Estimated cost, $10 000. J. Piquette, superintendent.

PESHTIGO—The Peshtigo Pulp & Paper Co., address J. A. Kittle, president, has awarded the contract for the construction of a 1-story, 70 x 242-ft. paper mill on Main St., to the Jorgenson Construction Co., Main St., Denmark. Estimated cost, $60,000. Noted Aug. 1.

SCHULLSBURY—The Local Co. plans to erect a mill and install a gasoline or oil engine and jigs in the zinc and lead mine three miles northwest of here. Estimated cost. $7,000-$8,000. R. F. Fox, superintendent.

TAYCHEEDAH—The State Engineer's office, Capitol, Madison, will receive bids until Sept. 5 for the construction of 10-in. sewer, 1 sewage disposal plant, consisting of tanks and filters, 262 linear feet of 5 x 6 ft. 6 in. tunnel for the Industrial Home for Women here.

Ontario

BOSTON CREEK—The Patricia Mining Co. plans to erect a mining plant and refinery and is in the market for all equipment.

LONDON—C. S. Hyman & Co., Richmond St., has awarded the contract for the construction of a 3-story, 80 x 100-ft. addition to tannery, to P. H. Secord & Son, Nelson St., Brantford. Estimated cost, $300,000. Noted Aug. 15.

Manufacturers' Catalogs

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, Ohio, has issued Bull. No. 22, dated June, 1919, which contains charts giving the relations in any shaft between power, shaft diameter, torsional stress and speed.

TATE-JONES & CO., Pittsburgh, Pa., has published several booklets: Bull. No. 158 deals with fuel oil burners for furnaces: Bull. No. 157 treats of fuel oil burners for boilers; Circular No. 129 describes fuel oil burning equipment for open-hearth furnaces. "Fuel Oil and Its Use" is the title of another new booklet gotten out by this company.

THE SPRAY ENGINEERING CO., Boston, Mass., is distributing Bull. 257 on "Spraco Air Washing and Cooling Equipment," which is especially applicable for steam turbine generators.

HOLZ & CO., INC., New York City, announces Bull. No. 4 on "A Machine for Determining the Resistance of Metals and Alloys to Abrasion (Wear)," which describes the Universal Type for tests on rolling or sliding surfaces, dry or lubricated, under variable speeds and pressures.

Coming Meetings and Events

THE AMERICAN CERAMIC SOCIETY will hold a meeting in Chicago, Sept. 24.

THE AMERICAN CHEMICAL SOCIETY will hold its Fall meeting in Philadelphia, Pa., Sept. 2 to 6 inclusive.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its Fall meeting in Chicago, Sept. 23 to 25 inclusive.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1919 convention in Philadelphia, Sept. 29 to Oct. 4.

THE AMERICAN GAS ASSOCIATION will hold its annual convention and exhibition of gas appliances and apparatus at the Hotel Pennsylvania, New York, Oct. 13 to 18.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its Fall meeting in Chicago, Ill., Sept. 22 to 27.

THE AMERICAN PEAT SOCIETY will hold its thirteenth annual meeting at Minneapolis, Minn., Sept. 22 to 24 inclusive.

THE AMERICAN STEEL TREATERS' SOCIETY will hold its first annual convention in Chicago, Ill., Sept. 22 to 27.

THE FIFTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in Chicago, Ill., Sept. 22 to 27 inclusive.

THE ILLINOIS MANUFACTURERS' ASSOCIATION will hold a National Conference on "Our Country First" in Chicago, Sept. 8 and 9.

THE INSTITUTE OF METALS DIVISION of the A. I. M. E. will hold its next meeting in Philadelphia, Pa., Sept. 29 to Oct. 4.

THE NATIONAL SAFETY COUNCIL will hold its Eighth Annual Safety Congress in Cleveland, Oct. 1 to 4.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its Fall meeting in Chicago from Sept. 24 to 27.

Stocks and Bonds

Closing Bid and Asked Quotations Aug. 28, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am.Ag.Ch.	97	99	Mat.Al.Wk.	31	34
do.pf.	97	99	Ten. C. & C.	13½	13¾
Barrett Co.	118	119	Un. Dyewood	...	...
do.pf.	...	113	do.pf.	...	...
Gen. Chem.	...	179	Va.-Car.Ch.	80	81
do.pf.	103½	108	do.pf.	113½	114¾
Int.Ag.Ch.	25	27			
do.pf.	82	84			

Bonds

	Bid	Ask
Am. Ag. Ch., 1st cv. 5s, '28	94	100
Am. Ag. Ch., cv. db. 5s, '24	101¾	107
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32	83	83¾
Va.-Car. Ch., 1 mtg. 5s, '23	95½	95¾
Va.-Car. Ch., cv.db. 6s, '24	102	103

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co.	88	90	P-A Pet & Tr	109½	109¾
Cal. Pet.	44	44½	do. pf.	...	...
do. pf.	80	82	Pierce Oil.	20½	20¾
Col. G. & E.	61	61½	Royal Dutch.	89¾	89¾
Mex. Pet.	176	176½	Sinclair O&R.	57	57¾
do. pf.	107	112	Texas Co.	249	250
Ohio Cit. Gas.	51½	52	Tex. Pac. Ld. Tr.	365	465
do. pf.	...	....	Tidewater Oil	238	245
Ohio Fuel S.	50	50¾			
Okla. P. & R.	10	10½			

Bonds

	Bid	Ask
Columbia Gas & Electric, 1 5s, '27	89	89½
Col. G. & El., std. 1 5s, '27	87	89¾
Pan-Am. Pet. & Tr. 1 6s, '19-'27	180	...
Pierce Oil, cv. db. 6s, '24	104¾	104½
Pierce Oil, cv. 5% Notes, '20	105½	120
Sin. O. & R. 1 ln. 7s, '20, with stk. war.	...	...
Sin. O. & R. 1 ln. 7s, '20 without stk war.	...	...
Texas Co., db. 6s, '31	102½	102¾
Union Oil of Cal. 1 5s, '31	94½	95
United Fuel Gas 1 mtg. 6s, ser. A., '36	96	98

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F.	39¾	40½	Pitts. Ste. pf.	88½	95
Beth. Steel.	80	84	Rep. Iron & Steel.	86¾	87
do. class B.	84	84½	do. pf.	104¾	105½
do. pf., 8%	111½	114	Sloss Sheff. I. & S.	62½	63¾
do. pf., 7%	100	107	do. pf.	90	95
Central Fdry.	26	30	Superior Steel	39¾	42
do. pf.	55	63	do. 1 pf.	102	...
Col. F. & I.	43	44	Trans. & W. Steel	56	57½
do. pf.	...	...	Un. Alloy St.	51	52¾
Cruc. Steel.	153	153½	U.S.C.I.P.&F.	31	32
do. pf.	...	...	do. pf.	67	70
Great No. Ore	42	42½	U. S. Steel.	102	102½
Gulf Sta. Steel	56	59	do. pf.	114½	115
do. 1 pf.	94	98	Va. Coal, I&C	60	61
Lack. Steel.	77	77½			
Mid.St.&Ord.	50½	50¾			
Nova Scotia Steel	72	72½			

Bonds

	Bid	Ask
Beth. Steel, 1 ext. gtd. S.F. 5s, '26	96½	97
Beth. Steel, 1 ln. ref. 5s, Ser. A, '42	88½	89½
Beth. Steel, P. M. & I. S. F. 5s, '36	85¾	86½
Buff & Susq. Iron, 1 S. F. 5s, '32	90	91¾
Buff & Susq. Iron, deb. 5s, '27	90	...
Cent. Found. 1 mtg. S. F. 6s, '21	86	86¾
Col. F. & I., gn. S. F. 5s, '43	90¾	91½
Ill. Steel, db. 4½s, '40	84½	85½
Ind. Steel. 1 mtg. gtd. 5s, '52	95½	95½
Lack. Steel, 1 5s, '23	96¾	97
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	92	92½
Mid. St. & Ord., clt. cv. S. F., 5s, '36	87	88
Nat. Tube, 1 mtg. gtd. 5s, '52	94	95¾
Rep. I. & S., S. F. mtg., 5s, '40	93½	93¾
Tenn. C. & I. R.R. 'gn. 5s, '51	87	89¾
U. S. Steel, S. F. 5s, 63	100	100¾
Va. C., I. & C., 1 5s. '49	84	85¾

Published SEMI-MONTHLY *on the* FIRST *and* FIFTEENTH *of each month*

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, September 15, 1919 *Number* 6

Chicago—Host to Science and Engineering

CITIES, like individuals, have character. Like individuals, also, they may be born with it, acquire it or have it thrust upon them. Furthermore, they have the blessed privilege of changing their characters if, perchance, they have been unfortunate in their first efforts at character building. Mention any great or prominent city, and instantly, if you are familiar with it, its leading characteristic flashes across your mind. Thus, to us, Chicago typifies Industry, and it is as a great industrial center that we think of her in the last week of this month, when she becomes host to scientists and engineers whose work forms the foundation for many of the industries in her vicinity. We can easily forget her appellation of the Windy City; we can pass by her vaunting "I Will" and substitute therefor a more appropriate "I Do"; and we can even forget such an occasional misfortune as an alleged pro-German mayor; but we cannot wholly obliterate our recollection of the hum of genuine industry that vibrates in her atmosphere, nor forget the mental impression that a tremendous production of the country's needs comes from within her confines or adjacent communities. Chicago typifies Industry.

It will tax even a great industrial, not to say industrious city, however, to give adequate attention to a large exposition and five conventions in the same week. We recall no other instance of such a conjunction in the history of scientific and engineering societies, and in some respects we hope that it will not recur in the near future. Good and impressive as it may be, it nevertheless taxes the ability of many who are interested in two or more of the events which are scheduled for simultaneous occurence; and it leaves one with a sense of indigestion, if indeed the prospect of so plenteous a program does not dull the edge of appetite and lessen the pleasure of anticipation.

The complete program for the week of September 22 appears elsewhere in this issue. The central figure is the Fith National Exposition of Chemical Industries, in conjunction with which will be held the regular meetings of the American Institute of Mining & Metallurgical Engineers, the American Electrochemical Society, the American Ceramic Society, the Technical Association of the Pulp & Paper Industry, and the American Steel Treaters' Society. The last named society, in addition to its meeting, will hold a special exhibition of heat-treating appliances and heat-treated products at the Seventh Regiment Armory. The Chemical Exposition will be held at the Coliseum and First Regiment Armory, and the meetings of some of the societies will be held there also. Details are given elsewhere in this issue.

The four North Central States, of which Chicago is practically the geographical center, are the subject of considerable attention in this issue of CHEMICAL & METALLURGICAL ENGINEERING. Already a great industrial region, we believe that it is destined to increase in importance and power, and assume a larger place in the scheme of national economy. Centrally located and having unexcelled rail and waterways, the factors are all present for utilizing in the highest degree the natural resources of the region in the shape of minerals and cheap power. Intelligent labor is plentiful, education is at hand in many forms, the spirit of scientific research is exemplified in State and national laboratories and institutions, and there is plenty of opportunity for professional intercourse among men similarly minded. It is with the purpose of familiarizing our readers with this important region that we publish symposia on the industries and resources of Illinois, Indiana, Michigan and Wisconsin. Those visiting Chicago during the week of September 22 will have an opportunity to make short excursions into the adjacent territory with the scientific and engineering societies, and thus visualize more clearly the conditions which we have tried to portray by word and illustration.

American Chemists In Peace Session

THE fifty-eighth meeting of the American Chemical Society at Philadelphia may be recorded as a distinguished and important event. Not only were the papers timely, but there were general features which could not remain unobserved by any thoughtful chemist who attended the convention. Of the general features we think the most noteworthy was the spirit of resolution that dominated the meeting. In April at Buffalo many members were still in uniform and had hardly returned to their normal work. Industrial chemists seemed still to be on the springboard, swinging their arms. Now they have jumped in and are swimming. There was no professional boasting. Everybody knows that the waters are deep and the goal distant; but the men are resolute.

Another note was the greater sense of the dignity and the public responsibilities of the profession. It is said of Professor TYNDALL that he had a faithful Scotch servant who rapped at his door every morning, uttering aloud the message with an unctious Scotch burr: "Ar-r-rise, sir! Ar-r-rise! 'Tis 7 o'clock and ye have a g-r-reat wor-r-rk to do this day!" One could almost imagine that the ghost of the old Scotchman had been passing before the doors of American chemists, declaring his message.

Too much praise can hardly be accorded to President NICHOLS and his able collaborators among the directors and the advisory committee, and to the Philadelphia and Delaware Sections for the completeness of the arrangements. The value of a man of inspiration at the head is sure to be reflected all along the line, but the earnestness and seriousness of the meeting extended far beyond any single man or group of men. A ringing note, however, was struck by the president in his call to organized labor, in response to the resolutions of the American Federation, to join with the Society in bringing about that quality of use and understanding of science which it demands. It was a hearty and honest call, made with the welfare of all in view.

Repeated again and again was the demand that chemsits be men of broad and abundant culture. The reasons given for this are twofold: that in research a trained and active imagination is required, and in industry, it is the chemist who represents to all the men employed the scholastic and philosophical elements of manufacture. Here indeed, as one of the speakers at the banquet emphasized, the man of culture is most needed. Many of the men who work with their hands have not trodden along the delectable paths of life. Many feel that they have not had a fair chance, and many indeed are right; they have been unfortunate in their surroundings. It is here that the chemist who, being proficient in the greatest of the arts, which is the art of living, may function to that betterment of this war-weary and distressed world which is the heart's desire of all good men.

The Potentiality of A Glucinum Industry

IN 1902 Mr. J. H. L. VOGT stated in the *Transactions* of the American Institute of Mining Engineers, vol. 31, p. 128, that between 0.01 and 0.001 per cent of the entire earth's crust is glucinum. In DANA'S classical "System of Mineralogy" the enumeration of localities where various glucinum minerals are found shows that they comprise a large list; while Bulletin No. 624 of the U. S. Geological Survey, on "Useful Minerals in the United States," shows that we have a relatively large quantity of glucinum minerals in our own country. In addition to this information regarding the occurrence of glucinum and its minerals, we have available many experimental data on the production and on the valuable properties, *sui generis*, of the metal, its salts and alloys.

Under these circumstances one might be led to expect that the glucinum industry is already a *fait accompli*, whereas in reality as long ago as June 14, 1916, Dr. J. W. RICHARDS stated in a paper read before the American Institute of Chemical Engineers that "dealers in rare chemicals will charge you, at present, $300 per ounce for a specimen of it" (glucinum). And in the *Revue de Chimie Industrielle* for June, 1919, we observe the prophecy: "A day will come when its [glucinum's] uses will probably increase considerably. It is only a matter of realizing the economic conditions of production and price."

These facts will prove of interest to those who have at heart the potentialities of new industries. Elsewhere in this issue we publish an extensive compendium of our chemical and metallurgical knowledge of the metal, covering the subject from the time of the element's discovery up to a very recent date. We hope and believe that it will stimulate interest in the subject and contribute in some degree to the establishment of a glucinum industry in this country.

The Fallacy of Class Distinctions in Chemistry

IN A notice issued some time since by the New Jersey Chemical Society it was recorded that "In order to promote contact of the industrial chemists with teachers of chemistry in the State of New Jersey, the committee on membership announced that those engaged in educational work, both collegiate and preparatory, would be welcome to membership in the Society."

We are glad to learn it. And if it indicates that the founders thought to make the Society a body of technical chemists exclusively, it is evident that they have resolved to correct the error.

We have been very fortunate in this country in keeping men engaged in pure and applied chemistry within the same organizations. The only difference between the two pursuits, as has often been repeated, is that in pure science one selects his own problem and takes his own time over it, while in applied science his problem is given to him and his time is limited.

There is no room for snobbery in either division. Let us imagine a man engaged in pure research who scorns industry as a dancing master scorns rubber boots and who declares himself to have "no interest in anything that is useful"; let us imagine him as soaking in soothing unreasonableness and ignorance of industry and its hot struggles that kill the weak and exalt the strong. How he behaves is a matter of taste, but so long as his work is important he cannot keep his work from counting in industry.

We declare that it is impossible to keep industry away from pure science, provided always industry follows research as it should. Of late we have found the demand growing urgent in properly conducted industrial research laboratories for advanced physical chemists. The time saved and the unnecessary experiments that are avoided by profound scholarship are no less than amazing. It is right here that the chemical philosophy of such savants as THEODORE W. RICHARDS, JULIUS STIEGLITZ and other great teachers comes into play. Abstract studies into the nature of chemical reactions have blazed the trail for many an industrial advance. No man who takes a forward step along the ways of pure science can keep enlightened industry out of his tracks. Such a pioneer does not need a factory number.

As for snobbery on the other side—the belief that because industrial chemists who have passed the stage of hack work are different in any particulars of merit from those who teach because they are better paid—it is absurd. The capacity for administration is an endowment rather than an art to be acquired; and so is teaching. So, too, is the capacity for research. They are gifts, like red hair, and some few of us have the first of these blessings, a few have the second and a few enjoy the third. The vast majority of mankind are better off at other tasks than any of the three mentioned. But the work of each is needed, and all function best when they are in association and live in comity. We have seen good time wasted in teaching students of chemical engineering how to operate simple apparatus which they might have learned from a skilled laborer; the while a course in physics which would have opened their minds to what they needed most was being neglected.

There is every reason why we should avoid class distinction in chemistry. We hope the Princeton and Rutgers faculties and the high school teachers generally will join the New Jersey Society. It will be an excellent thing for the teachers to see the many applications of their subject in everyday doings and things. It will enable them to blow the breath of life into their work and to explain the reason why abstractions that seem to be only "mind-improving" school book agonies are in constant use in daily life. For the chemist in the works whose operations are likely to be circumscribed by the limitations of routine practice, it will be an inspiration to foregather with men who select their own problems and dig into the unknown.

Recognizing the Importance Of Non-Metallic Minerals

A FAVORITE expression of a friend of ours is that "periodically we ought to revise our prejudices." Likewise we ought periodically to extend our vision, revise our classification of essentials and non-essentials, and readjust our concept of the relative importance of things. If prejudices are susceptible of revision, and we may pause to remark that they are, then certainly it is possible occasionally to take stock of our industries and their needs and revise our estimate of the relative importance of, let us say, minerals.

We venture the assertion that there is a wider familiarity with the production, treatment and uses of metallic minerals, such as galena, blende, hematite, chalcopyrite and pyrite, than with such non-metallic minerals as dolomite, talc, feldspar, fuller's earth and gypsum. The reasons are obvious. Minerals of the first class produce the common metals, and have the metallic luster and other physical properties that distinguish them, even for the layman, as something of importance in the earth's crust. The non-metallics, on the other hand, are apt to lack even distinguished appearance, being earthy and unattractive. Furthermore their uses are likely to be less apparent, and consequently they are not regarded as economically important. Not the least factor in drawing attention to the metallics is the amount of research that has been devoted to them by both Government and private agencies. In fact the pendulum of mineral research has been swinging so strongly in the direction of the metallics that we have been in danger of forgetting the importance of the non-metallics.

If the reader is interested in gaining an insight into the importance of the non-metallics in our industrial life, he will read the contribution of Mr. LADOO, published elsewhere in this issue. The non-metallics are the basis of many of our chemical industries; they form the raw materials out of which the finished product is fashioned, or, quite as often, they are used in the form in which they are taken from the earth, requiring no beneficiation or treatment whatsoever. Oftentimes their properties are obscure and the reason for their action poorly understood. This leads to rule-of-thumb application, to empirical use, and often acts as a bar to progress.

The great need of the non-metallic mineral industry in the United States today is systematic research prosecuted with as much intelligence and vigor as has been expended on metallic minerals for the past decade or more. The Bureau of Mines is an excellent agency to undertake this work as far as its national aspect is concerned. State institutions of learning can supplement the work either in co-operation with Federal authorities or by independent investigations on minerals of importance within their own borders. We believe it is not too optimistic to predict that ten years of research of the kind indicated will place our chemical industry and allied industries on such a footing as will establish them permanently in competition with similar industries in other countries, provided always that we have raw materials of equal quality and quantity.

Mechanical Charging Of Lead Blast-Furnaces

IT IS popularly supposed that it is more difficult to run a lead blast-furnace successfully than one smelting copper or iron ores—at least the operators constantly emphasize the extreme necessity of a most uniform charge column. DWIGHT long ago pointed out that a distinct gradation from fine at the side walls to coarse at the center is a prime essential of good furnace work, but no considerable segregation in sizes or in materials is allowable either vertically or longitudinally, else overfire and serious losses in recovery will ensue. Not that a uniform charge is not extremely desirable on any furnace, for it unquestionably is, but metallurgists believe that a lead furnace will stand less abuse than any other common smelter.

Twenty-five years ago hand-charging was universal practice; ores were bedded by hand, carted and dumped on the furnace floor, there to be shoveled into the furnace top at a total expenditure of perhaps one hour's labor per ton of charge. In its entirety this labor-wasting system is now seldom encountered, although mechanical devices for bedding are even yet rare. The first long step in advance instituted a charge car to be filled with several tons of miscellaneous materials by barrows, then to be hauled to the furnace and dumped into the shaft. In this manner about three tons of charge can be put into a furnace per man-hour. Labor efficiency is again tripled by most modern systems of mechanical assembly and charging.

Arguments against an exclusively mechanical system on the ground that it causes segregation lose weight when coming from men who are using a charge car not only narrower but actually much shorter than the furnace top. This is said with all due regard to the ideas of those who wish the charge car distinctly smaller than the furnace cross-section, so that it can be placed as desired, into this or that corner, side, or end of the furnace, to humor the peculiarities of accretion and charge descent. But are not these abnormalities mostly due to inferior charging? Then why spend good money in getting a correct mixture to the charging floor, and waste it in one fell drop?

Various causes other than inertia have prevented ready adoption of labor-saving devices at lead plants. Differences in general plant arrangements make it impossible to copy widely a successful layout, while variation in furnace top construction requires special design of charge car itself, so that a car very successful on a hooded furnace would be useless on another whose gases were drawn off below the floor or through a thimble. Mechanical handling in general is accompanied by rough handling, which is disastrous to the friable sinter forming such a large proportion of the present burden. Again, since no device will be perfect, irregular furnace operation will require at times uneven corrective charges; in other words, the system to give uniform charges should be flexible enough to give non-uniform charges when desired to control the furnace action.

Combine all these requisites in a layout which will minimize the cost of plant, operating charges and the handling of materials, and the problem is by no means an easy one. The Dwight-Messiter system so successfully operating in copper smelters has not found much favor in lead plants, principally because the extensive conveyor system involves much handling—that is, many drops—and because certain portions of the charge, such as sinter, flux and coke, do not require bedding, in fact are preferably placed in the furnace in layers. Therefore it seems probable that, for economical construction, sinter can be passed through bins of fair reserve capacity, while limerock, slag, coke, or other materials of uniform analysis can be merely dumped from a trestle, and drawn off into a tunnel below, the toes and ends of the piles remaining as surplus emergency stock.

A series of individual bins have in certain instances been successfully substituted for the time-honored ore-beds. They are much more expensive to install, especially if each has a weighing mechanism attached, and they require excessive switching by the charge-collecting car. If but a hundred pounds are drawn off for each charge, a small shipment is quickly exhausted. Ore-beds containing a thousand tons of material or more have many points of metallurgical advantage, if only in making for uniformity in furnace operation. Excessive labor is not essential for their assembly; a rectangular tank-like bin covered by a tripper on a low traveling bridge will build as good a bed as can be done by the most skilful laborers.

So much for the storage end. The engineer will next concern himself with getting the material into a charge car in uniform layers. Mechanically this may be done by bringing the charge car to the stock, or *vice versa*, either by rail or conveyor. As before noted, the first mentioned scheme has been installed successfully, but requires much switching and expensive maintenance of a scale car, or if a rugged hopper car is used, will involve many costly weighing devices. By the second plan, if a series of smaller receiving bins are assembled over a single loading track, a minimum of charge-car movement and a very few "weighing-off" conveyor-feeders would do the work. Either arrangement can closely simulate successful hand-filling practice and by regulation of speed of car or ore-stream, "humps" of material can be built up as required by the furnace man for corrective purposes.

To take the best advantage of the close control thus available in the condition of the charge as it arrives at the furnace mouth, it is essential that the burden be placed into the furnace in practically the same condition as it is delivered. That this is only approximated is easily seen from present arrangements. The wheels of the charge car itself may be about two feet above the floor, carried on a transfer, while the shaft may be open eight to ten feet to the bottom of the smoke flue. A six-ton charge dropping sheer ten feet would appear to be disastrous to the stoutest furnace construction—as a matter of fact, the charge runs slowly out of slots in the car, and strikes a deflector on its way down, not only reducing the impact but correcting the segregation inevitable from center charging.

A charge properly assembled should not need distributors or deflectors to get it into a lead blast-furnace correctly. A car with a real quick-opening flat drop-bottom, of the same cross-section as the furnace mouth, should be able to place the charge into the furnace in the same condition as it arrives. The impact of the falling mass would then be a factor of importance and could most readily be reduced by a low-hung car entering a hooded top, with the burden kept as close to the rail as metallurgical circumstances will permit.

Thus would the maximum value of mechanical charging be attained. It is evidently independent of the method of storing the components, of gathering them or getting them into the charge car. The main thing is to get the materials into the furnace in a pre-determined and controlled manner. At present the deflector controls the situation, but the question is raised, Could not the distribution be more properly done under closer control and at more leisure in a charge car so designed as to dump quickly and without further segregation?

Co-operative Industrial Research Laboratories

EARLY last winter Mr. C. E. Mees, head of the research laboratory of the Eastman Kodak Co., delivered an address in New York on Research Laboratories in Industrial Establishments. He spoke from the vantage of ripe and successful experience. He gave many valuable hints, and pointed out not a few hazards in well-meant laboratory practice. It was an excellent address. Later Mr. P. G. Nutting, head of the Westinghouse research laboratory at Pittsburgh, presented a paper on Institutes of Applied Science, in which he outlined in considerable detail the qualifications which a research institution should possess to be efficient in "turning out experts and in establishing vital and fundamental principles." He outlined seven principal types of research institutions that are already in existence in this country, and concluded his paper with enumerating the benefits to be gained by a great series of such organizations which should cover over thirty fields of applied science. His sketch of plans for the conduct of such co-operative institutes was illuminating, and in many respects admirable.

Just now, however, we want to emphasize the immediate need of research in industries, the need of it today; in our native clays, for instance; in the cement industry; in pulp and paper; in refractories, despite the work already done, for the prosecution of what Victor Meyer called pyrochemistry; and in many other directions. When captains of industry are so minded they can get a first line on what they need in many different ways. The main thing required is intelligence at the source. Industrial establishments must retain a reasonable measure of individuality, and if this is not to be found in standard products it may be looked for in methods. Natural raw materials cannot be economically standardized; we have to take them as they come with varying geologic histories and of diverse chemical composition.

And while our interest is in industries as made up collectively of many plants, we cannot ask the individual manufacturer to consider his own responsibilities lightly, or as merely incidental to the whole. He must bear his own establishment constantly in mind, if he is of the right sort and wants to keep ahead of the game. The way to do this is by progress rather than by secrecy. Given two plants, one modern and well administered, the other antiquated and operated by rule-of-thumb methods, it takes no gift of prophecy to foretell which will succeed and which fail. It is not secrecy that counts; it is capacity. The great purpose of co-operative research is to keep up the tone of the whole of an industry. This is essential for national reasons, in order to prevent failures and the consequent miseries of unemployment no less than to avoid that general ill-repute into which the incompetent few can bring all engaged in any single line of manufacture. The really able manufacturers are those who see to it that they keep ahead. They acquaint themselves with principles rather than with details of which their competitors are ignorant. They ascertain if any one else is working along their particular lines, whether in universities, private laboratories or endowed institutions. This is not accomplished by spying or underground methods; it is the result of being informed, of speaking the language, of familiarity with the literature—and in large part it is the reward of intelligent curiosity.

In short, the really able manufacturers are men of science, or they are closely associated with such persons of standing. In this wise they become familiar with the philosophy of their various processes. Also they attend meetings which would provide no enlightenment to their unreceptive competitors because the latter class do not grasp the vast complex of relevancies in applied science. The competent always have something on the stocks, in one laboratory or another, if not in their own, and they reap rich harvests accordingly. Old Uncle DANIEL DOLLARDOODLE never could make out how they turn the trick.

The White House Conference on Labor

EARLY next month twoscore or more carefully selected men will gather in Washington at the invitation of the President to seek a solution of the labor problem. Precedent does not encourage one to be hopeful that such a gathering, or any other, can solve the problem. Great questions like this do not usually have an "answer" that is adequate, requiring only search that it may be found. Ten years ago there was the White House conference of Governors, to consider the subject of conservation. The interchange of views undoubtedly did good, but no comprehensive program resulted, because such a program, to be effective, required the active co-operation of a very large number of men, with very divergent interests.

It is quite true that the coming conference could recommend legislation by Congress, but it is extremely doubtful whether any vital legislation that would be recommended would be enacted. Even were Congress disposed to legislate, it would be very difficult to draw up desirable legislation. Suppose, for instance, it should be desired to legislate against strikes, as it is desired to do in the case of the railroads. How could a line be drawn, defining in what industries or at what plants strikes must not occur?

An awkward feature of such a conference is the matter of representation. It is very difficult to find real representatives of unorganized labor, while representatives of organized labor are exponents of a system that strikes at the very roots of industrial peace. There can be no true co-operation between employers and organized labor, because organized labor refuses to recognize quality.

An illustration will serve to emphasize the vital importance of this fact. There was a time, say 15 or 20 years ago, when the average steel mill produced little steel except ordinary "mild steel," which covered a multitude of characteristics little known and still less regarded, while some of them produced what was broadly known as "rail steel." The buyer had to take what he got. Gradually it developed that there was money in suiting the steel to the special requirements of the consumer. At first the steel mills yielded rather grudgingly to the demands of customers that they be furnished steel a little different, but soon this feeling was supplanted by an active desire to meet the precise requirements of the user. Instead of being content with filling, or attempting to fill, the expressed desires of the buyer, many mills established research departments, resulting in the mill being able voluntarily to offer the customer or prospective customer a steel better adapted to his requirements than the buyer had been able to conceive.

Thus there has been established co-operation between the seller of steel and the buyer of steel, and this co-operation has proved mutually advantageous. More steel is being made and consumed to-day than if this co-operation had not been developed.

The system of organized labor presents no such co-operation. It strives to prevent co-operation. The pay per day is to be so much, no matter what the day's service amounts to. No day's work is worth more than another day's work. It is as if the seller of steel should say: "Here is our steel. If your axle is not strong enough, buy more steel and make your axles larger. If 25 per cent of the sheets break in forming, buy one-third more sheets. That will give the steel mills more work."

What is desirable is the replacement of the system of organized labor by a better system, but in all probability organized labor will contribute the chief spokesmen for labor.

For some time there was a strong outcry against "paternalism" on the part of the United States Government. OTTO H. KAHN delivered a very forceful address on "The Menace of Paternalism" before the convention, at Chicago, of the American Bankers Association, September 27, 1918. The address was reprinted in pamphlet form and was read with interest and approval by a great many thinking men. The "menace" has now almost died out, not chiefly because MR. KAHN spoke against it, but chiefly because practical experience has shown that it won't work.

Paternalism, however, is paternalism, whether it be government paternalism or not, and the fundamentals are such that it is as insufficient if it is the one kind or the other. Now, unfortunately, a large part of the defense of "open shop" employers against unionization is the paternalism these employers practice. What is done may be, and probably is, in itself altogether unobjectionable. It is "good work," so to speak, but it is not co-operation, and it is co-operation that is requisite. Can the coming conference at Washington devise a method whereby there will be co-operation between the employer as an individual and the employee as an individual?

Readers' Views and Comments

War Department Deserts Chemical Warfare Service

To the Editor of Chemical & Metallurgical Engineering

SIR:—The editorial in your issue of Aug. 15, entitled "War Department Deserts Chemical Warfare Service," prompts this letter. As a chemist, I sympathize with your attitude. I believe that such of the recent developments in methods of warfare that are usually described as "chemical warfare" should be the subject of continued study and research. And much of this should be done by chemists and physicists of the best training and widest experience. On the other hand, I do not believe it necessarily need be done by a distinct branch of the Army organization. My experience as a Captain in the Chemical Warfare Service, A. E. F., leads me to believe that the various activities of the Chemical Warfare Service, with perhaps one exception, could be performed satisfactorily by the ordinary departments of the Army. An enumeration of such activities, with their disposition according to my idea, may justify this statement.

The study of gas mask chemicals must be made, of course, by chemists and physicists. But why should not this, as well as the production of the finished masks, which is but a manufacturing proposition after all, be under the jurisdiction of the Ordnance Department? Likewise, why should not the chemical research necessary to the study and development of toxic gases, the engineering research necessary to their manufacture, and their manufacture itself, be functions of the Ordnance Department? Another important activity of the Chemical Warfare Service was the training of gas officers who were to be responsible for the "gas discipline" of the troops. It seems to me that this is a purely military matter that can be handled by regular line officers as part of their regular duties. Certainly scientists are not necessary for this duty. I am assuming, of course, that the professional training of these line officers will be modified so as to make them competent to do this. It will be necessary in this connection for some soldier-chemist to write a text on "Military Gases" of the same general character as Weaver's "Military Explosives."

As the offensive use of gas has become largely an artillery problem, artillerists can be instructed in the special uses of the various gas shells, as they are at present instructed in the particular uses of shrapnel and high-explosive shell. The offensive use of gas from mortars and projectors and the use of smoke has largely been in the hands of specially trained "gas troops" under the Chemical Warfare Service organization. But in my opinion there is no necessity for such classification; they could very well be called engineers, or even given an infantry classification and organized much as the machine gun units are, in their relation to the rest of the Army.

On the other hand, I believe that there should be on the staff of each division, or certainly of each army corps, a soldier-chemist, whose chemical training must be the very best, and whose chemical judgment must be matured by proper experience, whose duty would be to investigate personally the gas activities of the enemy in his sector, so as to keep his commanding officer of the War Department advised of gas developments during the campaign. There might even need to be an emergency laboratory available to these officers. But this should be so near the front as really to serve its emergency purpose; much too near the front to serve as a research laboratory. These officers might properly be classified as a chemical service. But their number would be so small that even in this case I believe it would be better to classify them in one of the existing departments.

Thus, it seems to me that the proper activities of the Chemical Warfare Service can be apportioned among the existing departments of the Army. Perhaps it is the plan of the Army to do this very thing, and to abandon merely the Chemical Warfare Service classification, not its activities.

B. B. FREUD,
Associate Professor, Armour Institute of Technology.
Late Captain Chemical Warfare Service, A. E. F.

Experimental-Retort Tests of Orient Coal

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have just returned from my vacation and note that you have published "Experimental-Retort Tests of Orient Coal" in the Aug. 15 issue.

In the absence of Mr. McBride, who is at present away on vacation, I want to call to your attention that you omitted the special acknowledgment we gave Mr. Edwin Barnhart, engineer of tests for the Bethlehem Steel Co., who developed the retort, and Mr. D. H. Duvall, assistant chemist, who has conducted the retort tests for the company. We are indebted to them for their valuable assistance rendered at the time the tests were made.

I. V. BRUMBAUGH.

A Rapid Method for the Analysis of Red Lead and Orange Mineral

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the July 15, 1919, issue of CHEMICAL & METALLURGICAL ENGINEERING exception is taken by Mr. Eric John Ericson as to the proper credit for the method used in a paper on "A Rapid Method for the Analysis of Red Lead and Orange Mineral" published in the *Journal of Industrial and Engineering Chemistry*, vol. 8, No. 3, page 237, March, 1916. It is Mr. Ericson's claim that I failed to give him credit for a prior application of the method as used. The method as used in that paper is taken from the third English edition of Treadwell and Hall's Analytical Chemistry. Reference was made to that edition so that it would be applicable to the latest publication of that book. If Mr. Ericson would acquaint himself with the literature on this subject, he would find that these reactions are described substantially as given in Treadwell and Hall's first English edition.

The question of the decomposition of PbO_2 by H_2O_2 was first discovered by Thenard and was first carefully studied by Brodie in 1850 (Brodie, *Phil. Trans.*, 1850, p. 759; *Chem. Soc. Quart. J.*, IV, p. 194; *Chem. Soc. Quart. J.*, VII, p. 304). As Thenard discovered hydrogen peroxide and studied its properties in 1818, this phase of the matter seems to have been common knowledge for over a century. Brodie's work was a detailed study of the reaction:

$$PbO_2 + H_2O_2 = PbO + H_2O + O_2$$

This reaction is also mentioned in Watt's Dictionary of Chemistry, published in 1871, vol. 3, page 198.

In Treadwell and Hall's book credit is given to the method of Lux. In so far as the method under discussion deals with the decomposition of red lead by nitric acid, this is fully described by Lux in his paper on the "Gravimetric Determination of Minium," published in 1880, *Zeit. für Anal. Chem.*, 19. The other part of the reaction is described in Treadwell and Hall's book with no reference given, due probably to the fact that this matter was common knowledge for so long a time.

From a study of these references, it will be seen that I was correct in crediting the method as was done. It is to be regretted that anyone making the claims which Mr. Ericson has made would fail to make a thorough study of the prior work done on this subject. While his method is a most excellent one, he has probably claimed too great originality for himself. In the light of these earlier investigations the mere fact that Mr. Ericson used this method for a dozen years in the zinc industry, and on Joplin ores principally, does not establish the claim that he should be credited with the prior application of this method as it refers to the analysis of red lead and orange mineral.

At the same time, it is indeed strange that he has only made the discovery which he did in respect to the credit he presumes to be due him after more than three years, the original paper being published in March, 1916, while his letter appears in July, 1919. It is apparent he has shown a great disregard of former investigations and publications.

JOHN A. SCHAEFFER,
Chief Chemist.

The Eagle Picher Lead Co.,
Joplin, Mo.

Western Chemical and Metallurgical Field

Boulder County Tungsten

READERS interested in tungsten are undoubtedly acquainted with the fact that this specialized branch of metallurgical industry has been marking time for several months, but they may not know that the mines and mills in Boulder County, Colorado, are almost completely abandoned. This region, the most important American tungsten source, shows many after effects of the wild flight of market prices. Fabulous quotations early in 1916 produced a record tonnage by the use of unusual expedients, and when the market settled to a relatively narrow fluctuation during 1917 (around $24 per unit), a substantial output was forthcoming from the mines and mills developed during the boom. This price remained approximately stationary up to the end of the war, and was affording a good return, as may be surmised when comparing it to a pre-war price of $6 per unit. Unfortunately, however, when the War Minerals bill was under discussion in Congress, the prediction was freely made that Colorado ferberite would soon be selling for $30 per unit WO_3, a prediction never realized, but which caused many of the small leasers and operators to curtail their mining and hold back their concentrates in expectation of the higher price. This somewhat concerted action cut into the 1918 production, and the result was that when the larger producers began shutting down in the fall there was really but a modest amount of spot ferberite in existence.

Thus all the mills in the district are now shut down; the principal ones being the Wolf Tongue Mining Co., at Nederland; Vasco Mining Co. (American Vanadium Co.) at Tungsten; Primos Chemical Co., at Lakewood; Rare Metals Co., at Rollinsville; Tungsten Products Co., at Boulder, and the Red Sign Mill, at Ferberite. Operators, large and small, are waiting for a high tariff to exclude cheap Asiatic ores; meanwhile large quantities of the latter are being imported and will command the market for months to come, tariff or no tariff. However, there is little or no ferberite to be had, and many users require this pure mineral rather than the imported ore, high in tin, manganese and copper. A decided premium is therefore to be expected, which may well grow to a point where mining in the richer Boulder veins will again be possible. As a matter of fact, leased ore is now being taken from the Black Rose mine at Dry Lake, some 4½ miles from Nederland, and shipped to Denver for magnetic concentration to supply a sizable contract running over the balance of 1919. This may be the forerunner of a revival in ferberite.

Dr. Eckley and some of his associates at the University of Colorado were able to perfect a chemical process for the production of very pure tungstic oxide from impure materials, and their commercial plant (Black Metal Reduction Co.) at the mouth of Boulder Canyon has been in operation for nearly two years. They first bought up mill wastes from their immediate neighborhood, a fine, impure product which could not be cleaned by water concentration. This was subjected to an alkaline fusion, the mass then leached, the filtrate purified and finally WO_3 precipitated pure enough to pass the exacting demands of incandescent lamp makers. After the Colorado supply of low-grade tungsten was exhausted, some unsalable fines from Dakota were utilized. More recently good ferberite has been purified, but at present this plant is operating at half capacity on Chinese ore, laid down at the plant at a figure less than it can be delivered from mines a few miles away.

CHEMICAL & METALLURGICAL ENGINEERING has already published detailed accounts of the milling practice in Boulder County.* Briefly the process consists of crushing the ore for jigging to about ¼ in. so as to produce the minimum of fines. Jig tails are crushed to about 10 mm., classified, and passed over tables. Table sands are then reground and concentrated as slimes on vanners and canvas tables. Since these articles were published there has been little change in the accepted ideas on gravity concentration—flotation has not been adapted to these ores—but very gratifying results have been obtained by magnetic concentration, especially by the Tungsten Products Co. All its intermediates needing cleaning are dried and then carefully sized in a series of impact screens, and the sized material passed in a thin stream through 3-magnet Wetherell separators adjusted to the product being handled. The first cross belt picks out most of the iron at a low impressed amperage, the second picks up some magnetizable silicates at intermediate amperage, while the last at high density takes out a high grade concentrate, commonly averaging well above 60 per cent, and leaving a tungsten-free residue.

---

*S. Fisher, "Modern Concentration of Colorado Tungsten Ores," vol. 16, May 15, 1917, p. 559; vol. 17, July 15, 1917, p. 73.

The Tungsten Products Co. also has had success in manufacturing WO_3 by chemical methods and ferrotungsten in electric furnaces, its contracts for the latter having expired only recently. Its plant, in addition to producing tungsten compounds, is busy on experimental work on other electric furnace products. Ferrotungsten is produced by this company in knock-down furnaces of about 100 k.v.a. capacity. A steel shell about 4 ft. in diameter by 4 ft. high, split in halves, is tamped with a refractory lining and placed over a carbon terminal block flush with the floor. A little charge is shoveled in (ore, coke and flux), the single electrode lowered and current turned on. As the charge is reduced more ore is continually added through the open top; the metal accumulates as a button in the bottom of the furnace, while the small amount of slag is tapped periodically through the slot between shell-segments. Metal is left in the furnace, however, and it finally accumulates in the form of a short, thick cylinder, occupying perhaps half the furnace cavity. On cooling, the furnace is torn apart, the slag-free button broken under a skull cracker, further crushed by a steam hammer, and mixed by running through a screening bin and elevator system several times. Ferro is finally shipped to analysis in double canvas bags containing 80 lb. of the alloy.

Government Helium Plants

A recently issued pamphlet on the war work of the Bureau of Mines brings together the personnel and notices the main facts regarding their highly important work on helium. At our entrance into the war there was about 1 cu.ft. of the gas in bottles in possession of Dr. R. B. Moore of the Bureau, probably the available stock on this side. As a starter, however, the British Admiralty requested immediate delivery of 100,000,000 cu.ft., and a weekly supply of 1,000,000 cu.ft.!

Mr. G. A. Burrell, Prof. W. H. Walker and Dr. F. G. Cottrell successively directed the preliminary development of the plans for the so-called "argon" plants, and secured the co-operation of the Linde and the Air Reduction companies. Plants were constructed at Fort Worth, Texas, utilizing the well-known Linde and Claude processes, the former for producing daily 5000 cu.ft. of 90 per cent helium from 0.4 to 1 per cent natural gas, and the latter for producing 3000 cu ft. per day. Building operations were commenced in November, 1917, and gas was first produced in March, 1918. Both plants were able to make a gas of about 70 per cent purity, which was reprocessed in the Linde plant up to 92 per cent; this stage requiring some two months' experimental operation. Since that time about 200,000 cu.ft. of gas has been made, most of which was in drums at port ready for shipment at the end of the war. Plant 1 (Linde process) has since been dismantled, while the Air Reduction Co. operated a short time working out an improvement in the process, the Navy Department meanwhile taking physical possession of the plant.

Dr. R. B. Moore was given the direction of this work in June, 1918, and was actively in charge for about a year. The Bureau was especially interested in the process devised by F. E. Norton, which had been approved after careful investigation by the National Research Council. In this process triple-expansion engines are used, liquid is throttled and the heat interchanger and fractionating still are of new design. Multiple-expansion engines thus reduce the power for gas compression to a minimum. However, the development of a new process from laboratory size into the largest refrigerating plant in the world was attended with many difficulties, and the Norton plant (located at Petrolia, Texas) produced helium early in April, 1919. Gas of 21 per cent purity has been made, and it is confidently expected that high-grade gas can soon be produced by this plant on a large scale. A fund of $100,000 has recently been made available by the Army and Navy for necessary alterations to the plant and its operation as a production unit.

The Navy Department is now engaged in the design of the so-called "Production Plant No. 1" to be situated at Fort Worth. Its daily output will be 30,000 cu.ft., and a supply of 7,200,000 cu.ft. will be required for dirigible use. A modified Linde process will be used, the plant itself costing $1,700,000, besides $1,800,000 for a necessary pipe line. It is estimated that operating charges for the production required will total $750,000, and that the lease on the Petrolia gas field will cost $1,500,000.

Labor Troubles in Copper Camps

Rather interesting and unusual labor troubles are being endured in Nevada and Montana, but have been treated in radically different ways and with different results in the two instances.

During the last week in July, the shopmen and affiliated crafts of the Nevada Northern Railway, 125 in number, declared an unexpected strike for largely increased wages and certain unimportant changes in the conditions of employment. This railroad, as is perhaps well known, is owned by the Nevada Consolidated, and transports ore from its shovel pit to the mill at McGill, some 20 miles distant, as well as connecting the copper camps with Cobre or Shafter, stations in northwestern Nevada on the Southern Pacific and Western Pacific, respectively, 120 miles north. Although the trainmen were not striking, there was no one to keep the engines in repair or to coal the tenders, so that ore trains ceased to run almost immediately, and a shutdown of mill and smelter was in close prospect.

However, before the stock of ore was exhausted, other unionized employees, from steam shovel operators to converter punchers, united in an ultimatum demanding that a list of concessions and an increase of $1.25 per 8-hr. day be granted by a specific hour on July 20. The threat was carried out, but the management had anticipated the action, so that the simultaneous stoppage of work of 3000 men in every craft without exception caused no large property damage through frozen furnaces. The company offered an increase of 75c. per day, claiming that this brings the wages to within 25c. of pre-armistice levels, that it is all the present shaky copper market will warrant, and that it re-establishes a scale equal to or greater than the scale paid at any other camp. The men soon receded to a demand of about $1 per day increase, thus leaving but a margin of 3c. per hr. between work and idleness. Attempted mediation by Gov. Boyle of Nevada and Federal Mediator Davies failed to budge either party to the dispute.

General strike conditions did not become particularly oppressive until the inhabitants began to miss the train service connecting them to the outside world. By permission of the strike committee, trainmen were authorized to take out the passenger trains, but the master mechanic of the railway—the only one doing any engine hostling—was unable to get more than three trains ready per week. Such conditions were admittedly temporary, however, and complete stoppage of service was in prospect.

A real idea of the gravity of the apparition confronting the citizens of Ely and McGill—300 miles by highway to the nearest considerable city—may be had from merchants' statements before the Railway Commissioners on Aug. 13, that they had supplies of staples for about a week, while dairy products and fresh meats were practically exhausted. One has but to pass through the region to realize that no supplies can be derived from the surrounding country. This condition at Ely but miniatures the state of the whole country in the event of a strike by the railway brotherhoods!

Settlement of the strike on the company's proposals was overwhelmingly voted by the employees after about a month's idleness, however, mining being resumed Aug. 29, and the smelter blowing in on Sept. 8.

A strike of metal workers and stationary engineers against the Anaconda Company on the other hand has not caused material curtailment of production—rather otherwise, strangely enough. Fortunately, the hoisting engineers in Butte are not involved, while mill and smelter men are continuing at work by virtue of signed contracts and tacit disapproval of the walkout by the metal trades. This difference came about over the negotiation of new contracts between company and the disaffected unions, the men feeling that they should receive $7 per day, while the company offers but $6.50. Minor questions are also at issue, but the wage rate seems to be the principal bone of contention.

The management has again employed tactics similar to those used in an electricians' strike three years ago; that is, they have called for volunteers among their technical staffs—draftsmen, engineers, chemists and research men—temporarily to take places of the missing mechanics. Of course it is impossible to man the shops completely, and no attempt is made to do any work except that connected with "trouble shooting" and the operation of power houses and substations. From the first, however, all the departments operated with accustomed smoothness, and in fact have readily absorbed the increased volume of ore delivered recently.

Some rather curious things have been demonstrated by this experiment. One is that one electrical engineer can satisfactorily replace about three electricians. Another is that the mysterious comings and goings of the regulation smelter mechanic are more camouflage than the performance of any necessary duties incomprehensible to the ordinary man of ingenuity.

Meeting of Electric Furnace Association

An important reorganization meeting of the Electric Furnace Association will be held at the Congress Hotel, Chicago, at 11 a.m., Monday, Sept. 22. Officers will be elected, and an open session held for discussion of papers on the commercial future of the electric furnace.

Eighth Annual Safety Congress

The National Safety Council will hold its Eighth Annual Safety Congress at the Hotel Statler, Cleveland, Oct. 1 to 4, 1919. A time-table of meetings and programs of the Chemical and Metals Sections will be published in the next issue. During the week of the Congress, the people of Cleveland will endeavor to excel the record established by St. Louis in its "Safety Week" last year. The goal is *no accident* in the week.

Talc and Soapstone Producers' Association

A meeting of all the talc producers of the United States, called by W. C. Boswell, president of the Harford Talc Co., Baltimore, Maryland, was held at the offices of the American Protective Tariff League, 339 Broadway, New York City, on Aug. 12, 1919, when the advisability of forming an association of the talc producers of the United States was decided upon. The protective tariff situation was also discussed.

The following representatives of the leading companies were present:

W. C. Boswell, Baltimore, Md., president Harford Talc Co
H. B. Barling, Talc Products Co., 11 Pine St., New York, N. Y.
Dr. S. Westray Battle, Asheville, N. C., president Biltmore Talc Co.
Thomas P. Dean, Springfield, Mass., manager Vermont Talc Co.
Michael Doyle, 44 Park Row, New York, president International Pulp Co.
R. W. Glendinning, Los Angeles, Cal., general manager Pacific Coast Talc Co.
Raymond Bardeen Ladoo, U. S. Bureau of Mines, Washington, D. C.
John S. Moore, Johnson, Vt., treasurer American Mineral Co.
R. L. Rutzler, Charlotte, N. C., Oliver Quartz Co., industrial minerals.
W. Edward Seybel, 280 Madison Ave., New York, N. Y., Uniform Fibrous Talc Co.
Frederick Green, Easton, Pa., John O. Wagener & Co., mineral pulp, talc and silicate.
C. J. Zimmermann, New York City, president St. Lawrence Talc Co., Inc.
T. S. S. Predmore, Kinsey, N. C., general manager Alba Mineral Co.
Anglo-American Talc Co., 82 Beaver St., New York City
J. T. Smith, Waterbury, Vt., manager Magnesia Talc Co

Seven other conpanies reported by telegram, letter or by proxy, so that probably 90 per cent of the talc production of the country was represented. After discussing the tariff question, the motion to form an association was carried, a committee on organization appointed to draw up a constitution, and the following permanent officers were elected: President, Freeland Jewett (president Eastern Talc); vice-president, W. E. Seybel, and secretary-treasurer, R. B. Ladoo.

The Association of Talc and Soapstone Producers agreed upon at this meeting is the first and only one of its kind in this country. The objects of the association will be the betterment of processes and methods used in the mining or quarrying, and treatment for market of talc and soapstone; technical research into their physical and chemical properties looking toward the discovery of new uses and expansion of markets, and mutual exchange of technical, statistical and market information, expansion of markets through educational advertising, stabilization of markets and prices toward standardization of grades and tests, and the adoption of an efficient cost-keeping method. These objects have not been officially adopted by the producers, but probably many or most of them will eventually form a part of the constitution.

Metallography of Aluminum Ingot—Errata

In the article on the above subject in our issue for Sept. 1, pages 229-234, two unfortunate typographical errors were made which require correction. On page 229, paragraph 2, line 8, the text should read "relatively thick amorphous surface layer is highly *undesirable.*" On page 232, the illustrations of Figs. 23, 24 and 25 should be inverted in order to conform to the description.

Philadelphia Meeting, American Chemical Society

Report of Council Meeting, General Addresses, Dye Section and Division of Industrial Chemists and Chemical Engineers—Society Protests Against Subordination of Chemical Warfare Service—Record Attendance — Over 250 Papers Read at Divisions

THE 58th meeting of the American Chemical Society during the first week in September at Philadelphia was introduced, as usual, by a meeting of the council of the Society. This took place at the Hotel Bellevue-Stratford on Tuesday afternoon, Sept. 2, with President W. H. NICHOLS in the chair. Ninety-seven councillors were present. The editors of the Society's various periodicals were all re-elected, as was also Secretary PARSONS. The name of the Division of Industrial Chemists and Chemical Engineers was changed to the Division of Industrial and Engineering Chemistry. It was determined to hold the next Spring meeting at St. Louis and the annual meeting at Chicago.

Dr. B. C. HESSE was chosen to succeed himself as councillor at large. There are two such councillors at large who, with the president, the two last presidents and the secretary, constitute the advisory committee; a committee that has been in existence only two or three years, but which has been found of great help and convenience in the administration of the Society's affairs.

It was provided that sections of the Society may have associate members who shall have no voting privileges but shall pay not less than $2 annually. The main purpose of this is to provide for the organization of bodies of men interested in some special field of chemistry which may be more or less localized.

Professor WASHBURN reported on the interallied Chemical Conference, in Paris and London. It is planned to provide for a continuation of International Congresses of Applied Chemistry under the auspices of the interallied body, but no date has been fixed upon as yet. The next meeting is to be held in Italy in 1920.

In regard to the committee on spelling, nomenclature and pronunciation it was resolved to ask the British chemical societies to co-operate. Both Englishmen and Americans will probably follow their national fancies in regard to old words, but there's no reason why they should not unite on new ones, more particularly in scientific nomenclature. It is very important that all English-speaking peoples should understand one another in this respect.

The leading feature discussed was in relation to the proposed bill (S. No. 2715) for the reorganization of the Army. A recommendation has been made by the Chief of Staff, General Peyton C. March, and the Secretary of War whereby it is provided that what is left of the Chemical Warfare Service shall be turned over to the Corps of Engineers. In effect it legislates chemically trained men out of control of the chemical work of the Army and it was held that the matter is too important even to respect West Point traditions. The following telegram was sent to Senator Wadsworth, chairman of the Senate Committee on Military Affairs:

> The American Chemical Society, of a membership of over 13,500 American chemists, today by its authorized representatives unanimously adopted the following:
>
> Whereas the recent war has clearly demonstrated that the advancement of science, through competently directed research in military problems, is indispensable to the security of the nation, and
>
> Whereas the bill recently introduced into Congress, Senate 2715, 66th Congress, by the General Staff of the Army, providing for universal military service and the reorganization of the Army, is of such scope and effect as to impede inevitably the development of all technical and scientific work of the Army by placing

> it under the absolute control and direction of purely military officers who do not have the requisite scientific knowledge, and
>
> Whereas an organization so constituted could not function efficiently, and in time of stress would prove to be an element of fatal weakness and could never hope to attract to itself other scientific and technical experts without whose aid modern warfare cannot be successfully conducted; now, therefore, be it
>
> *Resolved*, That the American Chemical Society emphatically protests against this or any other bill which does not provide for commissioning staff officers in the corps and departments in which they are to serve, and which does not accord to the technical men the same recognition and opportunity throughout every grade and department of the Army as are accorded to the men trained for a military career only.

We have written so much in favor of this very attitude that we take pleasure in confirming it. It has nothing to do with urging gas warfare upon military authorities, but it does urge upon the Government the necessity of being prepared against it, and the only way to do this in regard to chemical problems is to have it done by chemists in a chemical division and under the supervision of chemists rather than of engineers.

The Council was entertained at dinner by the Philadelphia and Delaware Sections.

THE GENERAL MEETING

The general meeting of the Society was called to order Wednesday, Sept. 3, at 10 o'clock by Chairman **MINER**, who after a few words of welcome introduced the Hon. **JOSEPH S. MCLOUGHLIN**, Director of Supplies of the City of Philadelphia, who spoke on behalf of the city. To this President **NICHOLS** responded in appreciation and introduced the Hon. **NEWTON D. BAKER**, Secretary of War.

Secretary **BAKER** said that of the 17,000 chemists of the United States one-third had been in uniform in the Government service and one-third had been engaged in war industries. He doubted if any profession had contributed more to military service or to our national success in the war than the chemists. He outlined the plans for the future of the Army. As an instance of the requirements of war he related the fact that to support a 3-in. gun with ten men at the front there is needed a factory with 300 operatives. The proposed law was not dealt with in detail, in fact the question of disposal of the Chemical Corps was hardly touched upon except for the fact that it is evident in the mind of Secretary Baker that ample provision is to be made to maintain scientific standards. We understand, however, that the Chief of the Engineers does not want the Chemical Division and the former heads of the Chemical Divisions have expressed themselves against the proposed law in its original shape. It may be that the Honorable Secretary in time will see over the heads of his staff officers and realize that a West Point man with all the responsibilities for canal and river and harbor improvements is no more peculiarly equipped to direct chemical research than he is to direct medical research. The new plan for the Army provides that there shall be a great educational institution, taking young men on to serve for a few years and sending them back to civil life well equipped with a craft. They plan to build a vast engineering school to include chemical as well as other branches of engineering and they expect to maintain a great research establishment to which the leading men of the country are to be invited to work and to exchange views with military men. The address was very appealing and masterful and contained many interesting facts. For instance, there are from 9 to 10 million men, young men, dead from the war, and its cost is 2 million million dollars, whereas all the property of the U. S. is valued at 186 thousand million dollars. There was a lower percentage of suicide, insanity or crime in the U. S. Army than in any other army or any known similar number of civilians.

The Secretary of War received the sincere applause and appreciation of all present, except in regard to that feature of his Army bill that seems defective in its provision for chemical research.

Admiral **RALPH EARLE**, Chief of Ordnance, U. S. N., followed the Secretary of War and gave a full account of the use of explosives by the Navy. What is now needed is a smokeless powder that is not accompanied by a blinding flash when heavy charges are delivered.

Dr. H. J. **WHEELER** spoke on "Some Problems and

Methods in Agricultural Research." The address was in part historical in regard to agricultural chemistry in this country, but a number of present problems were outlined. He called, for instance, for research in regard to waste plants and waste plant products. There is promise in the utilization of milkweed, and, again, it is possible that values may be found for the Southern water hyacinth, which grows with extraordinary vigor. There is need for further research in regard to the chemical effect upon soils of lime, for instance, and in regard to the causes of acid conditions. Leadings are already provided for in these respects. Thus liming has been found to be detrimental under certain conditions and occasionally to incite plant diseases. In Hawaii the presence of an excess of manganese prevented the absorption of iron and the consequent production of chlorophyll, which was overcome by treating the leaves with a solution of iron. Only this year it was discovered that potash from Searles Lake frequently had a toxic effect which was found to be due to the presence of borax. More research is needed as to the effect of boron and borax upon vegetable life. Occasionally it appears that well-drained upland soils become acid, and Hartwell and Temper of Rhode Island have shown that often the toxic effect is not due to acidity but rather to the formation of aluminum sulphate. Sometimes, too, aluminum nitrate is formed, and that also acts as a poison. Study is needed as to the effects upon all kinds of plants of aluminum compounds and the lower oxides of iron.

The Department of Agriculture has found a large number of organic compounds in the soil which are deleterious in their nature. For instance, leachings of soil in which grass grows have been found injurious to many kinds of trees. One of the difficulties in regard to agricultural research is that the salaries paid to men of wide learning and experience are less than those paid for common labor.

Professor **EARLE B. PHELPS** spoke of "Stream Pollution and Its Relation to Chemical Industries." He believed that the drafting of legislation in regard to stream pollution should be in the hands of an intelligent board such as the River Board of Great Britain, and recommended that the subject be placed under Federal control.

BUILDING OF ATOMS AND THE PERIODIC SYSTEM

Professor W. D. **HARKINS** of the University of Chicago delivered a very interesting address to a capacity audience on "The Building of Atoms and the Periodic System." His theory in regard to the constitution of atoms has been published from time to time chiefly in the *Journal of the American Chemical Society*, but a number of new and very interesting points were brought out. Professor Harkins postulates that the helium atom is the product of combination of hydrogen atoms and that other elements are either combinations of helium atoms —which are the even numbers—while those having odd numbers are combinations or rather amalgamations of helium atoms with those of hydrogen. Elements of even number are much more prevalent than those which are odd. Differences of the atomic weights of elements of even number of approximate multiples of 4 are offered in confirmation. Still another confirmation is the successful experiment of Sir Ernest Rutherford, lately achieved, whereby he shot alpha particles at great speed into a glass tube containing nitrogen. The walls of the tube were sufficient to bring the particles to a standstill. Nitrogen being an odd element (number 7) is held to be made up of three helium atoms and two of hydrogen. The impact of the alpha particles which, being positively charged, may serve as nuclei of atoms, disintegrated the nitrogen so that a quantity of hydrogen was found in the tube.

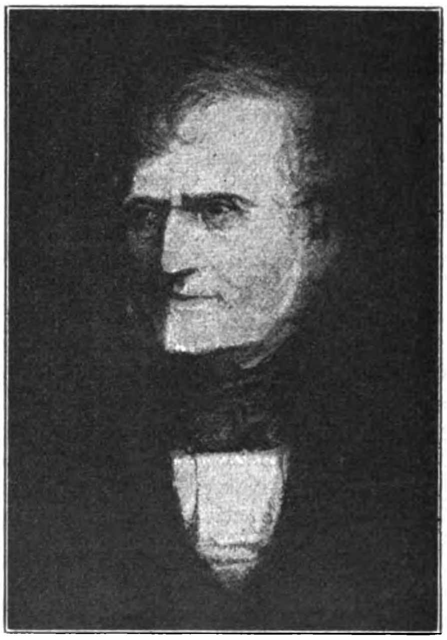
Mr. **ROBERT R. FISHCELIS** followed with a short paper on "The Chemical Laboratory as a Publicity Factor."

Social Features

The smoker was one of the best ever held by the Society and the entertainment provided was at once instructive and amusing. The singing was led by a song leader of the War Camp Community Service, and the songs, both originals and parodies, were unusually good. The reader can imagine, for instance, what an excellent parody on "Smiles" can be made by a chemist who is familiar with "smells."

One of the features of the smoker was a one-act play portraying an early chemists' meeting in the cellar laboratory of Robert Hare, Jr. at the time when Dr. Joseph Priestly came to Philadelphia. Not the least instructive feature of the smoker was a series of animated mechanical films by the Bray Studios.

The banquet on Friday night was a brilliant affair. Dr. Harry F. Keller acted as toast-master and introduced Dr. Edgar F. Smith, Provost of the University of Pennsylvania, who responded with a few brief references to the life and work of Robert Hare, an early Philadelphia chemist. Following Dr. Smith's remarks each one present was given a steel engraving of Robert Hare, a copy of which is reproduced with this report.


ROBERT HARE (1781-1858)

Mr. Ellwood Hendrick, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING, responded to the toast "The Chemist of the Future" and emphasized the need which the chemist has of someone in his profession to speak with the voice of authority. Following him the Hon. Edward E. Beidleman, Lieutenant-Governor of Pennsylvania, spoke on some phases of the present industrial conditions, saying that we must quit playing to the galleries on political issues, study civic problems and increase production. Dr. Harlan S. Miner, presiding officer of the Philadephia Section, responded for the Section and told something of its work. Mr. Edward James Cattell, Philadelphia Statistician, made one of his characteristic humorous speeches. He was followed by Dr. Charles L. Reese, the presiding officer of the Delaware Section, who told of this infant organization which has over 400 members.

The program of the evening was closed by speeches from the only surviving charter members of the American Chemical Society, Dr. Charles F. Chandler and Dr. William H. Nichols. The latter suggested that one of our industrial troubles is due to the high cost of loafing and that a suitable remedy would be to stop loafing and substitute efficiency in our industrial life.

The all-day boat ride on the Delaware River, tendered by the Delaware Section, afforded an excellent opportunity for making acquaintances and talking over technical problems. The boat left Philadelphia at 9:45 A.M. and made a round trip to Deep Water Point. This afforded an opportunity to gain an idea of the extent of the chemical industries along the waterfront. A stop was made at Hog Island, where the *Sinsinawa* was launched. A complimentary box lunch was served on the boat.

Entertainment for the visiting ladies comprised several luncheons, automobile rides, a theater party, and an organ recital. The ladies also attended the banquet and river excursion.

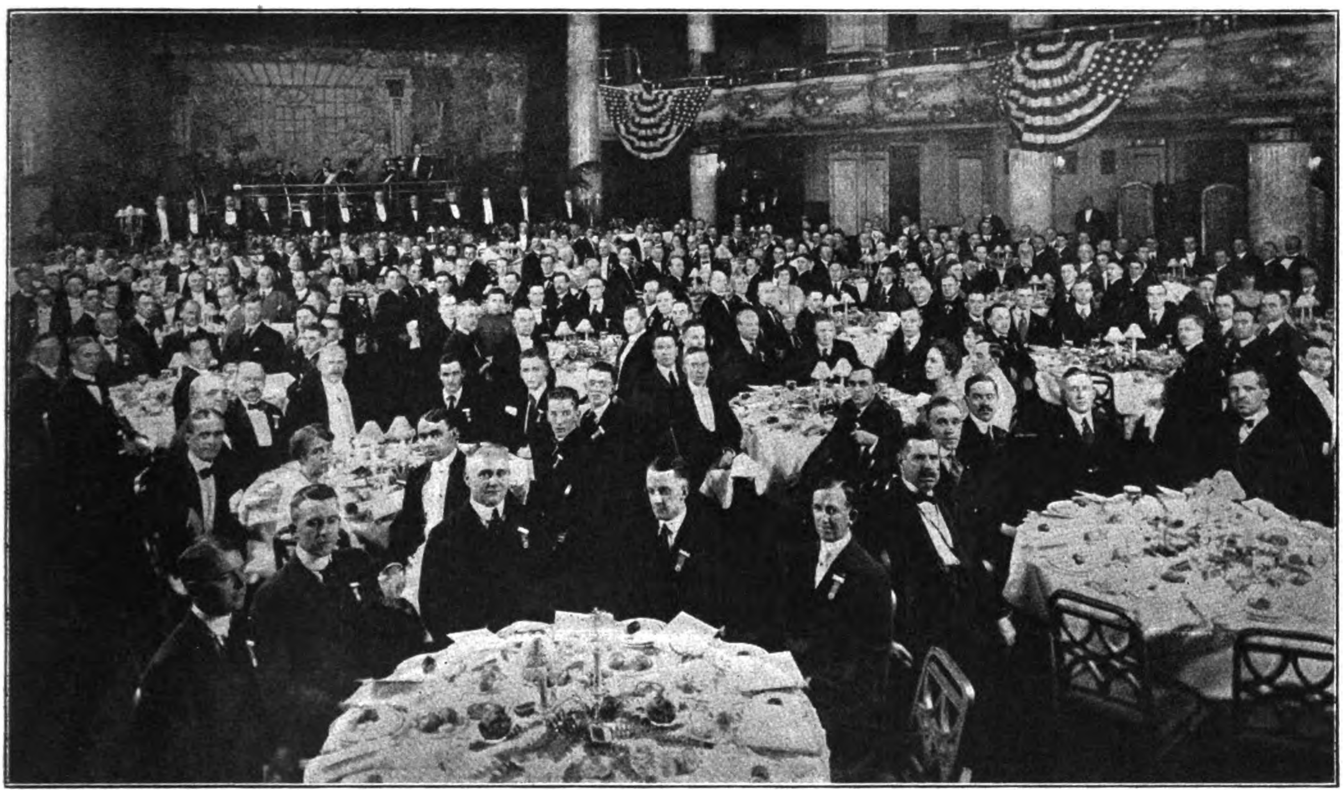
The local Section is to be commended for its support of a daily issue of the *Catalyst*, which is the official bulletin of the Philadelphia and Delaware Sections. This contained registration lists, reports of meetings, announcements of programs, and last-minute information on convention details. This excellent feature of the meeting was in charge of the editors, Sydney Davis, Robert P. Fischelis and F. C. Zeisberg.

Presidential Address—Research and Application*

BY DR. WILLIAM H. NICHOLS

For nearly half a century, it has been the custom in this Society to give its president every year "his day in court," and in conformity therewith many brilliant addresses have been delivered, and almost every conceivable subject has been discussed. It is therefore becoming more and more difficult for the incumbent to select a theme which shall have the merit of novelty, unless, perchance, he is himself working in the laboratory, and can bring forth some new and shining example of the progress of his science. I have not the good fortune to be so situated, and I must perforce satisfy myself with some other line of procedure in the hope that even in a discussion of old and well-known facts, some new light may be thrown, which will not be altogether without value. I have therefore selected for my subject, "Research and Application."

Research in the distant past was the privilege of the few. In chemistry, during the Middle Ages, the alchemists were practically the only ones pursuing it, and they in secret, and not always from the highest of motives. Working by themselves, as they did, they had not the great advantage of meeting and discussing with others similarly engaged, and using their progress and mistakes to intensify their own increase in knowledge. Thus it has come about that the science of chemistry is little more than a century old, and its tremendous advances only a few decades. The first chemical society in the world was born in Philadelphia in 1793, and yet the real advances have been made since the formation of this Society in 1876. Since that time, however, the advance in knowledge has been startling, not alone in this country, of course, but in all civilized countries.



ANNUAL BANQUET, AMERICAN CHEMICAL SOCIETY, SEPT. 5, 1919, AT BELLEVUE-STRATFORD, PHILADELPHIA

---

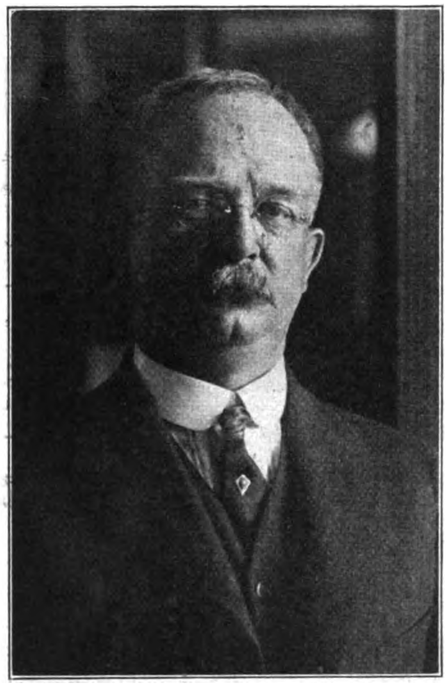
*Abstract from the paper read before the American Chemical Society, Sept. 4, 1919.

It is not boasting to say, however, that during all that time, the progress in this country has been in nowise behind that of the best anywhere, which our public is at last beginning to recognize. Particularly during the trying period of the war, when vast and new problems were suddenly thrust upon them, the work of our chemists has been beyond praise.

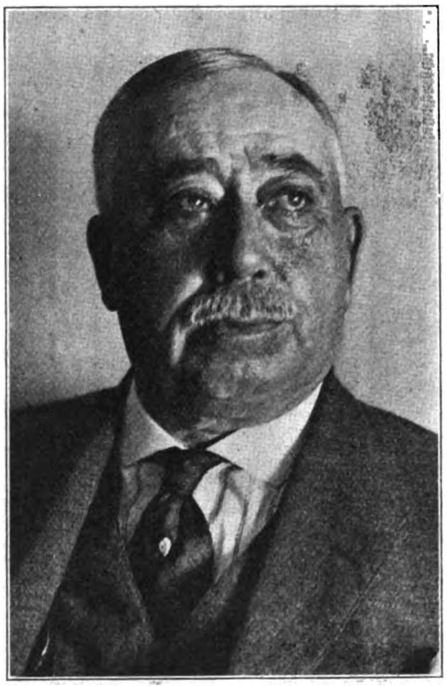
At the foundation of all this advance, research is firmly imbedded.

No one can deny that there have been accidental discoveries, some of great moment; but this has not been and will not be a safe dependence. Accidental discoveries are not to be relied on, of course, although they are not to be scorned. In chemistry the accidental good fortunes have usually come to those who were really seeking, although possibly for something far different, but, note this, they were usually made by men qualified to recognize an important discovery when it flashed across their vision.

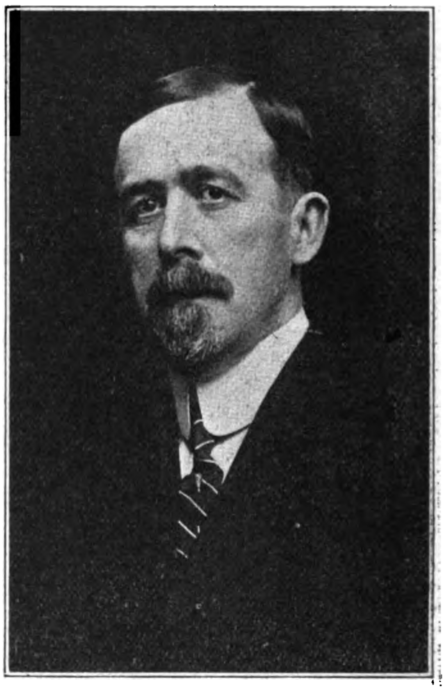
Research, of course, is not of necessity to result in invention. It may in that respect terminate in a cul-de-sac, from which, with present knowledge, there is no egress, or what more frequently happens, it may lead to a line of reasoning, which in time leads to another, and so on, until suddenly a bright light illumines the way, and a goal of the greatest possible importance is attained. Many instances illustrative of this will occur to you.



CHARLES L. PARSONS
Secretary American Chemical Society



WILLIAM H. NICHOLS
President American Chemical Society



HARLAN S. MINER
Chairman Philadelphia Section

True research must be intentional and intensive. We must have imagination, it is true, but we must have more than that. There must be the foundation of sound education, and the ability to extend it to embrace new and unexpected knowledge, and apply this in turn as we progress upward.

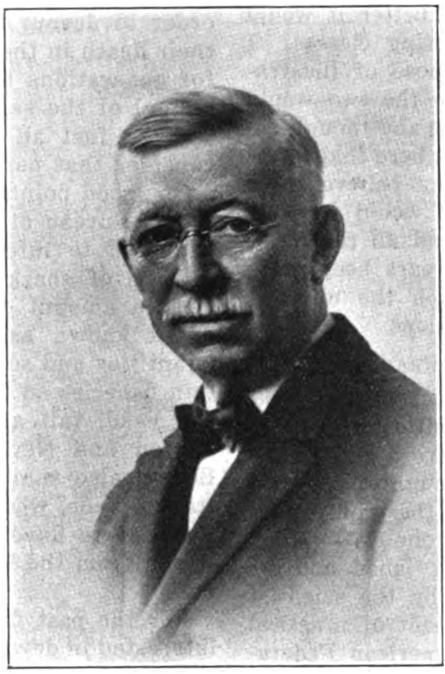
To fit a man for research in chemistry or any other science, many things must be accomplished before the candidate is ready to take his first advanced step. Many methods of procedure have been suggested, and some heat of argument generated; but all agree that education which produces real practical knowledge is absolutely essential. All agree, also, that the person to be prepared must be a likely subject; and that energy and time should not be wasted on those who do not show that they possess certain necessary qualifications. I think that it will also be generally admitted that the teacher himself should not only have great attainments, but must also possess the rare quality of being able to transmit knowledge in such a way that it will be truly absorbed by the pupil and form part of him. One of the greatest mathematicians I have ever known was about the poorest teacher. He knew but could not impart. The future of the world, therefore, depends in a very large degree, on the teacher in the school and on the professor in the college. They have an opportunity to mold the world, which many of them thoroughly appreciate. Alas, in most instances, the consciousness of work well done is about their only reward. Some day, and I hope not a very distant one, it will be generally recognized that, like other laborers, they are worthy of their hire, and their compensation will more nearly approximate the value of the work done. When that happy day arrives, they may experience a little less of the satisfaction of sacrifice, but they will have other comforts and hopes which will more than make this up to them and to their families. Like others before me, I advise the people of this country that they can make no better investment than one liberal enough to cause the teaching profession to attract not only those whose high sense of duty leads them to embrace it at a sacrifice, but also those who cannot afford to make the sacrifice, however anxious they may be to do so. Men preparing for research must have the best men in the country to guide them, and it is not fair to expect these men, as so many have done in the past, to live the narrowing life of poverty. Neither is it wise.

There are a few foundations specifically provided for chemical research, such as the Warren Fund of the

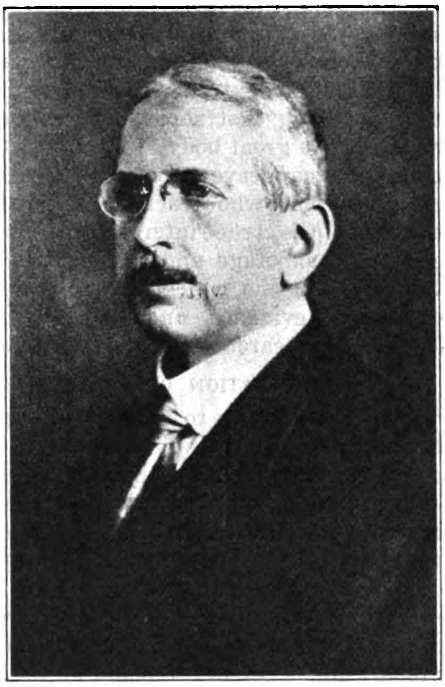
American Academy of Arts and Sciences, the C. M. Warren Fund of Harvard University, and the Wolcott-Gibbs Fund of the National Academy of Sciences. There are a number of foundations for promoting research generally which have included chemical research within their fields, such as the Bache Fund of the National Academy of Sciences and the Elizabeth Thompson Science Fund. The Rockefeller Institute for Medical Research fosters chemical research contributory to its main object, the Carnegie Institution of Washington supports chemical research in its general policy of advancing knowledge through research. The newest of all is the fund recently placed at the disposal of the National Research Council for stimulating chemical research. There is need for many more foundations if we are to keep pace with the rapid strides of civilization, or better still, to determine the direction they will take.

The importance of research is being more and more recognized and understood by the public. One of the most encouraging evidences of this is shown in the preamble and resolution adopted recently by the American Federation of Labor at Atlantic City, indicating, as these do, a clear appreciation by that great association of how much we all depend on what science will disclose to ameliorate the conditions of the future. It is well worth while to read these in full here. They are as follows:

BERNHARD C. HESSE
Councillor at Large



EDGAR F. SMITH
Provost, University of Pennsylvania



GEORGE D. ROSENGARTEN
Chairman Program Committee

> Whereas scientific research and the technical application of results of research form a fundamental basis upon which the development of our industries, manufacturing, agriculture, mining, and others must rest; and
>
> Whereas the productivity of industry is greatly increased by the technical application of the results of scientific research in physics, chemistry, biology and geology, in engineering and agriculture, and in the related sciences; and the health and well-being not only of the workers but of the whole population as well, are dependent upon advances in medicine and sanitation; so that the value of scientific advancement to the welfare of the nation is many times greater than the cost of the necessary research; and
>
> Whereas the increased productivity of industry resulting from scientific research is a most potent factor in the ever-increasing struggle of the workers to raise their standards of living, and the importance of this factor must steadily increase, since there is a limit beyond which the average standard of living of the whole population cannot progress by the usual methods of re-adjustment, which limit can only be raised by research and the utilization of the results of research in industry; and
>
> Whereas there are numerous important and pressing problems of administration and regulation now faced by Federal, State and local governments, the wise solution of which depends upon scientific and technical research; and
>
> Whereas the war has brought home to all the nations engaged in it the overwhelming importance of science and technology to national welfare, whether in war or in peace, and not only is private initiative attempting to organize far-reaching research in these fields on a national scale, but in several countries governmental participation and support of such undertaking are already active; therefore be it
>
> *Resolved*, By the American Federation of Labor in convention assembled, that a broad program of scientific and technical research is of major importance to the national welfare and should be fostered in every way by the Federal Government, and that the activities of the Government itself in such research should be adequately and generously supported in order that the work may be greatly strengthened and extended; and the secretary of the Federation is instructed to transmit copies of this resolution to the President of the United States, to the President pro tempore of the Senate, and to the Speaker of the House of Representatives.

I hope and believe that this matter, coming as it does from a new direction, will be most seriously considered by the proper authorities—not that it has not already been well understood in Washington, but that renewed interest may be taken and even more liberal appropriations granted. The Federation resolution urges that "a broad program of scientific and technical research is of major importance to the national welfare." Good! Now that everybody is agreed, how was it possible that for so long a time this belief was held by so few, and these composed almost entirely of men of science? The question, therefore, is squarely before the country, and the urgency of it thoroughly appreciated by those who have the most to gain by it; namely, the workers on whose efficiency so much depends. Now this opens the way to a scientific solution of vital questions about which there has been such fundamental differences of opinion, based largely on what may be called the point of view.

CAPITAL AND LABOR

People have divided themselves into classes—a very dangerous course—and many, a very great many, have actually believed that there must of necessity be a deeply rooted difference between capital and labor, and that the true interests of either were entirely apart from those of the other. Many have held that labor is a commodity which it was to their best interest to get the most of for the least money, while many others believed that labor was the sole source of all wealth, and that the fewer hours worked, and the smaller the output of those hours, the better it would be, somehow or another, for the laboring classes. I have cited the extreme views for purpose of illustration, realizing that somewhere between the two would be found the great body of all reasonable and thoughtful men. We may leave out of consideration here that ultra-extreme class who teach, whether they believe it or not, that the true interests of labor would be best served by sabotage and syndicalism, and all the other fantastic notions which have of late years been more or less in evidence, and liable to catch the unwary. To these, research presents no attractions.

CO-ORDINATION OF STUDY AND PRACTICE

Now I am going to venture to suggest to the workingman who is earnestly desirous of bettering his own and his family's condition that there are a good many sciences besides chemistry and the engineering and abstract sciences in general. Some of these he is better able to study and practice than any one else. Many of the fundamental truths concerning labor and its conditions would never be discovered by the scientist per se, because he has not had the benefit of practical preparation. Let our friends of the American Federation of Labor not be content with what the Government can do in the line of their resolution, good as it has been and will be, but let them start a carefully planned series of researches themselves, and follow them up until the truth stands revealed. They can depend upon the assistance of this great Society. The employers of labor have been doing this for years, singly and in groups, seeking the same end. The shining goal of all research is the truth, the whole truth, and nothing but the truth. Thus, starting from different angles, with fairness and thoroughness, the various so-called interests will arrive at the same truth, for there can be only one truth concerning any question. Thus will it come to pass that capital and labor will discover that the true interest of one is the true interest of all, and instead of bickerings and suspicions we will have that cordial co-operation which is absolutely essential if we would get the best out of this good old world.

Research leads to discovery. Discovery to invention. Invention—no one knows where. Applied and supervised by those prepared for the task, the strides of progress will be long, and the benefit to the human race in proportion.

Papers Read Before the Divisions

About 250 papers were given before the ten divisions, so that the best those who attended the meeting could hope to do was to hear about one-tenth of them.

A report on the Division of Industrial Chemists and Chemical Engineers and the Dye Section is given below. The Rubber Division will be reported in a following issue. A few notes taken from papers of other divisions are given, but these were not made complete. as many of them will be published in full in the near future.

USES FOR SHARKS

ALLEN ROGERS of Pratt Institute in an interesting paper before the Agricultural and Food Division on the utilization of sharks drew attention to the importance of overcoming modern prejudices against the shark and stated that from time immemorial the shark has been considered as an enemy to man and as a scavenger of the sea. It has been pictured as the cannibal of the deep, and in fiction has been painted as the vulture which lurks about the ill-fated ship in order to devour the unfortunate who may have met their death in the gale or on the reef. We, therefore. for generations have cherished an antipathy for this animal of the sea and have been very willing to accept as fact all of these stories, never stopping to consider that perhaps after all the shark might have a few good points in his favor.

The Bureau of Fisheries for several years has endeavored to interest the people of this country in the use of shark meat as an edible product, with a certain amount of success. In fact, that species of shark known as dogfish is being canned in large quantities and sold under the name of grayfish. Certain fisheries on the New England coast are removing the head, tail and fins and selling the product in Boston and New York as deep sea swordfish. In Boston also shark meat is being sold as such to the Italian trade, who appreciate its food value and enjoy its delicate flavor. Why then should we not take a lesson from the Italians and acquire the shark-eating habit?

For the past five or six years Dr. Rogers has been interested in developing a method for converting shark skins into a merchantable leather. As a result of this work several processes have been devised which have been assigned to the Ocean Leather Co., operating fisheries at Morehead City, N. C., and Fort Myers, Fla. This concern alone expects to get up to a catch of 1000 fish daily, although at present it is not taking this number. The skins are now being manufactured into leather, the livers rendered for their oil and the flesh converted into fertilizer stock. It is estimated also that at least 1000 sharks can be secured daily from the fishermen handling food fish, who at present. simply kill the sharks getting into their nets and throw them back into the water. By this wasteful procedure on the part of the fishermen at least 1000 sharks daily are destroyed along the Atlantic coast. Thus not only is the skin lost to the leather trade, not only is the liver oil discarded, not only is a large amount of fertilizer material made unavailable; but at least 50 per cent of the weight of shark which would be fit for human consumption goes to waste.

A conservative estimate based on the above figures indicates that for a catch of 2000 sharks daily, at an average weight of 200 lb., there would be 400,000 lb.

of fish. As at least 50 per cent could be used for human consumption, we would have 200,000 lb. daily, or 73,000,000 lb. annually. Assuming that the market price could be set at 10c. we have a saving of $7,300,000.

The question of supply is one that is constantly being asked. From personal observations and from those who are most familiar with the subject, it seems evident that the supply is inexhaustible. Another question is often raised as to the best method to prepare the flesh for market. The answer is cold storage. This method, however, may not always be practical in isolated fishing stations. Recourse must then be made to salting, smoking or drying. The fresh meat, however, is the most delicious, and when boiled, broiled or baked furnishes a white flaky food closely resembling halibut or swordfish.

A source of food supply so extensive warrants our most careful consideration, and it is hoped that the time is not far off when we may overcome our prejudice and take advantage of nature's abundant supply.

GREATER EFFICIENCY NEEDED IN THE CHAMBER PROCESS

ANDREW M. FAIRLIE of Atlanta in his paper before the Fertilizer Division on the conservation of saltpeter in the chamber process stated that 14 per cent of the nitric acid in the Gay-Lussac towers was lost per cycle, and in connection with the prevalent protest against the high cost of food, means for conserving nitrate of soda in the manufacture of sulphuric acid has twofold interest.

The lowest possible consumption of nitrate of soda in the manufacture of suphuric acid means low cost for producing the acid, and, as sulphuric acid is the principal item in the cost of making acid phosphate, cheaper sulphuric acid should result in cheaper phosphate, and cheaper phosphate should result in cheaper food.

Nitrate of soda is itself an important ingredient of fertilizer, and any decrease in the consumption of nitrate for making acid should react in favor of a decreased demand, and so of a lower price, for nitrate of soda.

The various methods of introducing nitrogen compounds into the acid-making process were reviewed, and the methods in common use for controlling the chamber process briefly described. Attention is directed to the gradual extension of the analytical method for chamber-process control, and to the improved results attained where this result has been adopted. The Gay-Lussac tower, as a means of recovering the nitrogen compounds, is not an ideal or yet an efficient piece of apparatus, and the need exists for either an improved type of Gay-Lussac tower, an auxiliary to the Gay-Lussac tower, or a substitute for that tower, capable of effecting a higher percentage of nitrogen recovery.

SLIDE RULE FOR CALCULATING SO CONVERSION

F. C. BLAKE of Wilmington in his paper before the Physical and Inorganic Division on the construction of special slide rules for chemical calculations gave a description of two rules. The one on SO_2 conversion to SO_3 should be in general use in sulphuric acid works.

In general, if an equation can be written in the form

$$f(x) = f(y),\ f(z)$$

a slide rule may be constructed so that the value of any variable may be found if the others are known. As a simple illustration, consider the computation of conversion in the contact process for the manufacture of sulphuric acid. Let

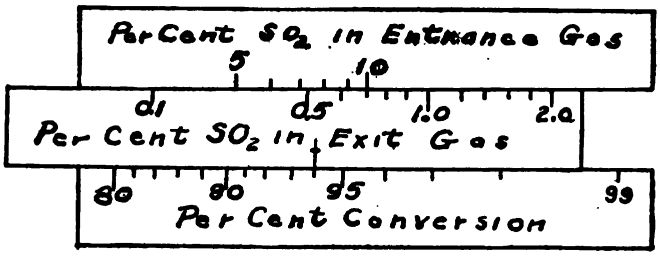
a = per cent by volume of SO_2 in entrance gas
b = per cent by volume of SO_2 in exit gas
c = per cent conversion = per cent of SO_2 converted to SO_3.

These quantities are related by the equation

$$c = \frac{10000(a-b)}{100a - \frac{3ab}{2}}$$

This form of equation is not suitable for the construction of a slide rule, but it may be rewritten as

$$1 - \frac{c}{100} = \left(\frac{100}{a} - \frac{3}{2}\right) + \left(\frac{100}{b} - \frac{3}{2}\right)$$



SO_2-SO_3 RULE SET, 10 PER CENT ENTRANCE, 0.7 PER CENT EXIT EQUALS 94 PER CENT CONVERSION

The slide rule scales for the solution of this equation are in the accompanying figure. The upper scale is laid off proportionally to log $\left(\frac{100}{a} - \frac{3}{2}\right)$ the slider to log $\left(\frac{100}{b} - \frac{3}{2}\right)$ and the lower scale to log $\left(1 - \frac{c}{100}\right)$. These scales are laid off from right to left so that the marked values a, b and c will increase from left to right, as this is the most natural method of reading scales. The proper values of SO_2 in burner gas and exit gas are set together and the conversion read opposite the arrow. The zero point (i.e., log 1) of the lower scale is moved to the left relative to the upper one to make the rule more compact and the arrow displaced the same distance to give the correct reading.

The Dye Section

The meeting of the Dye Section was so well attended that it was necessary to move from the little "Green Room" set apart for it to one of the large restaurant rooms on the main floor. Dr. **CHARLES L. REESE**, the chairman of the Section, presided. In his introductory remarks he said that some two or more years ago he told the American Cotton Manufacturers Association what American chemists could do for them, and he was now ready and willing to review what they had done for them in the meantime. There is some $100,000,000 invested in the American dye industry, and it has taken the courage of conviction to make these ventures. Every new industry has high production costs in the beginning and manufacturing units have to be made small to avoid extraordinary losses. Manufacturing costs, however, are improving. He explained the origin and workings of the Chemical Foundation, discussed the licensing system as developed in England and predicted that within another year's time the dye industry would be much further advanced. Indanthrene dyes (a type of the much needed fast cotton vat dyes) are being produced today and he believes that in six months the consumer will have all of these that he desires. This belief was later confirmed by Dr. GRINNELL JONES, who said he had seen factories at work producing vat dyes and large works already built and ready to begin. There is more indigo made in this country today than was imported before the war.

Major T. H. SILL followed with an address on "The Present Condition of the German Dye Plants." In February and March of this year Major Sill inspected the leading German dye plants to observe what they had done in war. He was under the impression that they were in pretty bad shape, but soon found them to be in perfect operating condition, except in a few minor details. They retain their complete forces, and owing to the stress of war, the plants have been enlarged. They are operating on only about 10 per cent of a peace basis, but they keep their labor occupied in cleaning and polishing and away from bolshevist agitation. Result is everything is remarkably cleaned up. At the time their only shortage was zinc dust, pyrites and chrome ore, which they can probably get now. They were also short of lubricating oils.

The best and most modern of the German works is the Bayer establishment at Leverkusen, opposite Cologne. Their offices and clubs for workmen are almost palaces and the place is nearly a city by itself. One of the first persons he met was Prof. Duisberg, their managing director, who will be remembered by those who attended the Eighth International Congress of Applied Chemistry in New York in 1912 as providing a perfect specimen of German competence and boastfulness. The genial Dr. Duisberg assured Major Sill that as for the Bayer works, they were really such novices at the art of making poison gases that they could hardly be reckoned as a factor in it. The Major soon learned, however, that this same Bayer Co. had been leading producers of mustard, diphosgene, etc. The Bayer Co. has been making artificial rubber at the rate of 150 tons a month. The price has been high—30 to 40 marks per kilo—but this, it is believed, will soon be greatly reduced and the company expects to compete with natural rubber. Another very interesting development was the manufacture of 1000 tons per month of sulphuric acid from gypsum.

The establishment of Weiler ter Meer at Merdingen he found well kept up and that it had in 1918 erected a palatial clubhouse for its workingmen.

Kalle & Co. at Bieberich looked run down and delapidated, but the Hoechst works, formerly Meister Lucius & Brüning, had had a wonderful development, doubling their employees from 8,000 to 16,000 men. They were pioneers in making poison gases and oxidized vast amounts of ammonia to nitric acid. This concern is in excellent condition.

The Badische Aniline & Soda Fabrik at Ludwigshaven employs about 16,000 men, and it is older and more congested than the Bayer works. It has continued to make dyes during the war and it is said to have not only a large accumulation of dyes but still greater stores in the interior of Germany. A little further up the river is the $75,000,000 Haber process works of which the research laboratory alone cost over $1,000,000. Here and elsewhere in Germany there were some 650 tons of ammonia per day produced. The country has been producing more ammonium products than before the war.

Major Sill did not believe that the layout of the German plants was better than those of America, although in addition to the advantage of experience in technique they have certain features that are improvements over American practice. Among these he mentioned the habit of building water towers around chimneys and thus utilizing a good part of the heat; a better distribution of filter presses, a novel nitration system and remarkably high-grade lead fittings. On the other hand, they lack elevator and conveying machinery and there is a great deal of transportation of materials from plant to plant which would never do in this country.

These German plants, he said, owing to their equipment, their competent staffs of chemists and their chemical versatility, constitute the technical reason why there lie 38,000 of the flower of American youth dead in France, with a far greater number maimed. It was one of the directors of the Badische Aniline & Soda Fabrik who lately said: "We [Germans] need be in no terror as to the future of our dye industry. American textile manufacturers will not continue to pay high prices, and when the markets are open, so-called patriotism in that country will vanish like hoar-frost on a sunny Spring morning."

At this point Dr. Reese observed that while prices of American dyes might be higher for some time to come, the German product would have no advantage whatever as to quality.

Dr. J. MERRITT MATTHEWS gave a review of the dye situation.

We have discovered, he said, that the real secret of German success was to be patient in research and to carry research into the factory. A study of the dye census of 1918 shows that the American industry supplies a large proportion of the colors needed. The development has been somewhat one-sided, but this has been for economic reasons. In England they have brought out a good range of vat dyes and of true alizarine colors; on the other hand, the American development has been greater in azo and direct cotton colors, also in fuchsine and color lakes for paints and printing inks. Rating the American industry as 100 per cent, he thought the British coal-tar color industry will represent 50 to 75 per cent in comparison. France was like the rest of us before the war and expanded less for self-evident reasons. Since the armistice she has gone ahead, her chief accomplishment being the production of indigo. Other dyes are less important in quantity. The close relations with Switzerland are already shown in the establishment of a branch in France of the largest Swiss works, the Society of Chemical Industry of Basle. It is likely too that the French oversight of the Badische will provide for some French chemists some important hints as to technique. Japan is a newcomer in the industry and has but one really effective establishment. That country is making less headway than the others.

We must bear in mind that the world market for dyes is not capable of very great expansion. Before the war Germany supplied from 80 to 90 per cent of the world trade. The Germans can soon reach greater production than before, and they are ready to go ahead again. Great Britain has laid out plans to take care of its home and colonial markets. And it will. The capital invested is large and the British government has gone into the partnership. It is a foregone conclusion that the British and Colonial markets will be withdrawn from the world's trade. And they will have a surplus to offer for the international demands.

In this country, Dr. Matthews figured, $60,000,000 to $80,000,000 has been invested in the industry. The capacity is large and it is growing. With proper encouragement from the Government he believes that in all events in a few years if not, as Dr. Reese believes, in a few months time, the gaps will be filled up. It can easily care for the American market and export the surplus.

France is resolved to develop, but it may use Switzerland in part and it may take dyes from Germany in part payment of indemnity. The Swiss have increased their coal-tar color industry threefold since the war and will probably rank next to Germany in efficiency and economy. So we shall have, competing for the world's market, Germany, Switzerland, the United States and England for certain and possibly France and Japan. Roughly, it may be divided as continental Europe 20 per cent, Great Britain 15 per cent, United States 12 per cent, Asiatic countries 45 per cent, South America 5 per cent, Africa 3 per cent. Only half of the world's markets are open, while productive capacity has increased threefold. Now, the salvation of the industry lies in intense research to develop uses for all by-products and raw and useful products from the same materials so that the making of dyes becomes incidental to the making of many other useful things.

Dr. **GRINNELL JONES** of the Tariff Commission discussed the progress of the dye industry as shown by the Commission's census of 1918. The production of benzene and toluene has far outstripped the needs of the color industry, being 52,000,000 gal. benzene and 14,000,000 gal. toluene in 1918. Five firms produced crude anthracene, but their joint product was less than 250,000 lb., which is not enough. The situation is improved. Carbazol was also first produced in 1918, but we are still short of carbazol products. A decrease is shown in the production of the easiest intermediates to make, but this is compensated for by the increase in more difficult intermediates and dyes made from them. This indicates an improvement in the kinds of dyes made. Another good feature is the decrease in the prices of dyes and intermediates despite increased costs of labor, construction and transportation. This means making steps toward a true competitive basis. Dr. Jones has seen a number of plants designed by German and Swiss chemists which were redesigned by American chemists to their great advantage in the economy of labor.

Mr. R. S. **LUNT** spoke of "The Quality of American Dyes," and declared that shipments are now running fully as close to standard as before the war.

Mr. H. A. **LUBS** reported a new series of indicators and Mr. H. D. **GIBBS** described the work of the color laboratory of the Bureau of Chemistry at Washington, D. C.

On Friday morning the Dye Section crowded the large dining room on the main floor of the Bellevue-Stratford. Dr. W. F. **EDWARDS** urged standardized tests for dyed goods in order to break down the prejudice against American-made dyes. Retailers, in order to avoid responsibility for the color quality of goods sold, declare that American dyes are not dependable and that their customers must take their chances in this respect. Now it is very easy to determine the color quality of cloth; just as easy as it is to make very simple steel tests, and the processes are inexpensive. The only thing required is an agreement upon standards, and it is to be hoped that the Dye Section of the Society will take the matter up and provide for this much needed achievement.

Dr. E. W. **PIERCE** of New York presented a very interesting historical paper on "The Application of Dyes." We shall only note that the reason why the dyeing of Tyrian purple remained a secret and that the dyers of it were social outcasts was because a putrefactive process was employed which rendered it next to impossible for anyone to go near the dye houses or to the men who worked in them.

One of the most interesting papers was presented by Mr. **EDGAR T. WHERRY** on "Crystallographic Identification of Five Isocyanines." He found that in the five instances mentioned, the identical substance might show a marked difference in the color of its crystals; that different batches of the same substance would vary from yellow to purple. This phenomenon, he said, was due to reflectional pleochroism, in which the color of reflected light varies according to the plane reflected to the axis of the crystal. Thus the color would range from yellow to purple as the crystalline habit developed one set of planes or another. This rare phenomenon explains the fact that a dye may vary in the color of its crystals while remaining the same in chemical structure and tinctorial effect.

Mr. W. H. **WATKINS** of the National Aniline & Chemical Co. presented a paper on "Observations on the Estimation of the Strength of Dyes." It was a contribution of great practical value, providing methods for adjusting differences between buyers and sellers.

Mr. E. K. **STRACHEN** of Buffalo, also connected with the National Aniline & Chemical Co., spoke on "The Application of Physical Chemistry Research on Dyes." This was of the sort to make our old-fashioned color chemists sit up and take notice. A number of very valuable curves were shown.

Division of Industrial Chemists and Chemical Engineers

The earnestness of endeavor of the members of this section and the successful work which they are thereby accomplishing was clearly demonstrated in the number and high character of the papers presented at this meeting. It seems truly marvelous that the wide field embraced should be so thoroughly covered in the short time allowed for the deliberations, and the result can only be attributed to the fact that each individual member, upheld by highly developed imagination, is following the ideal of benefit to the industry without thought of self. The direction of the work was carried on under Dr. H. S. **MINER**, chairman, with H. E. **HOWE** secretary. Two symposiums and 27 papers were presented. Abstracts of a few of these are given below.

Gas Masks in the Industries—A. C. FIELDNER. In order to promote the development of safe and suitable designs of gas masks of the Army type for industrial use, the Bureau of Mines has established a gas mask department at the Pittsburgh Experiment Station. The Bureau will co-operate with manufacturers of gas masks in approving them for use in the gases for which they are intended provided they pass the tests prescribed in Schedule 14. A 1000-cu.ft. gas chamber has been installed in which masks can be tested in various concentrations of any gas desired. Other equipments for making mechanical and chemical tests are also provided.

Division of Industrial Research. National Research Council—H. E. Howe. The speaker explained that this division is not a Government department but an organization with the purpose of developing research for the common welfare of the country's industries.

The Council will not itself maintain laboratories for conducting research, but will function to encourage research by men of the industry. It will accomplish this in making public the work done by others through the medium of pamphlets and data published in the columns of the American Chemical Society's journals.

The Value of Cost Accounting in Commercial Laboratories—William W. Caswell. Cost accounting systems, long considered an unnecessary frill and a burdensome evil, have come to be recognized as an important requirement in the conduct of general business institutions. Statistics show that of the 250,000 corporations doing business in the United States only 125,000 are making money, and that only 5 per cent of the total number have an adequate cost accounting organization. Investigation has shown the great value of this work, not as a means of record, but as a source of knowledge for the proper administration of the work.

The need applies equally in the commercial research laboratory. Here the question of raw materials and machinery accounts need not be considered, but rather the item of labor of chemist and department head is covered under direct expense, and burden or overhead under indirect expense. The cost embraces this direct expense plus the indirect, which includes the official salaries, etc. To this cost a fair percentage of profit must be added, in order to obtain price to be charged the client.

If this system is not used one job or one department will be supporting another, and an ultimate loss of money may result. Where so diversified a work is carried on as in this business the executive, to be successful, must have an accurate idea of what each department is doing. The various departments of a commercial laboratory ordinarily resolve themselves into analytical, research, paper pulp, textile, cement, oil and engineering laboratories.

An effective system must be simple and free from red tape. The executive must work with the accountant in establishing and carrying out the system with this thought in mind.

After the record has been carried on for a period of, say, one year, the data are then available for fixing prices to be charged for analyses. During this time the average costs may be obtained from working time required by different chemists on the same analysis. Future deviations from this average will serve to show up the weak and the strong operators, and awards may be given through praise or even a cash bonus. It is obvious that a skilled chemist saving the company money on each analysis is entitled to substantial reward. Efficiency is then increased by desire for this reward and the man develops a pride in his work.

A laboratory without a cost accounting system is like a ship without a rudder. The executive must know the details of his business. The object of this paper is to arouse the interest of each member in the development of his own business. Once installed he will ask himself, "How did I ever get along without it?"

The paper was commended highly by the members of the section and the author volunteered to help any member who would communicate with him, by giving the benefit of his own experience.

Modern Commercial Explosives—R. L. Hill. The processes of making the commercial explosives were given in outline. The explosive and non-explosive ingredients are made separately and then mixed under proper conditions. The well-known black blasting powder is still popular with the trade. The dynamites are classified as straight dynamite, straight gelatine dynamite, ammonia dynamite and ammonia gelatine dynamite.

The straight and straight gelatine dynamites under the old methods of manufacture are liable to freeze at temperatures as high as 50 deg. F. and the ammonium compound is substituted for the sodium and potassium in the production. Ammonium nitrate compounds are largely used in Europe, but the hygroscopic qualities make it hard to protect from deterioration in damp climates. The protection from this is usually taken care of by the use of a moisture-proof container.

Permissible explosives are used chiefly in coal mine blasting, where danger of ignition of mine gases exists. The substance is compounded with the view of having as little flash or fire with the detonation as possible. The explosion is not entirely devoid of flash, but the amount may be greatly reduced. The powder must have a large deficiency of oxygen, high amount of water content, as in $(NH_4)NO_3$, and be low in nitroglycerine.

The nitro-starches came into great demand during the war and make a good industrial explosive for some purposes. They have a high order of detonation.

The consumer of explosives is more critical of the product than in perhaps any other business. It is necessary to consider chemical properties from the time raw material arrives at the factory until the charge is planted by him. Careful chemical control is involved in every stage of manufacture. Testing galleries show proof of the finished product. Permissible limits of change or deterioration until put in use must be known. Specifications for the particular article desired should include strength, density, velocity of detonation, sensitiveness of the primer, consistency, water resistance, cold resistance and nature and volume of resulting gases.

Chemical Reagents Received by the Bureau of Chemistry During the War—H. E. Buc. The Bureau began testing samples sent in a great many years before the war and found the products satisfactory until about six years ago, when left-over chemicals began to come on the market. After 1915 the shipments became very unsatisfactory, about 150 analyses out of 1300 showing an excess of impurities. The labels on the bottles were inaccurate as to the contents.

In general the acids and alkalis were permissible and the soluble salts were acceptable, but not of a high degree of purity. The insoluble products were unfit for use.

Report on the Production of Synthetic Organic Chemicals in the Research Laboratory of the Eastman Kodak Co., 1918 and 1919—C. E. K. Mees. The work of commercial preparation of these compounds began in September, 1918, and has continued over a period of eleven months. Great help has been received from the chemists and manufacturers as well as the university laboratories, including the Universities of

Illinois, Missouri and Oklahoma, and the College of Forestry at Syracuse, N. Y. It is the desire of this organization to act as a clearing house for all this class of work. Five hundred and sixty chemicals were included in the plans and of these 348 were undertaken, with this laboratory working on 268 out of the latter quantity.

Chemicals of three degrees of purity were supplied to the trade, Eastman's Best, the highest grade; commercial grade, ordinary synthetic chemicals with impurities marked on the label; and technical chemicals. The last mentioned class was not made in the laboratory, but was purchased in commercial lots from the manufacturers and repacked in small quantities for users requiring it.

The financial statement for the period of 11 months of this work showed a loss of $17,397, of which $6000 is depreciation of stock caused by the difference in present market figures and the purchase prices with war-time inflation. As an example of the decreasing loss, the July figures show a total of $304—manufacturing loss. During this month there was $747 charged to depreciation and overhead expense. There is a current loss due to explosions incident to the experimental operations and for this reason a profit cannot be shown for several years to come.

A reduction of the loss might be effected by increased production, involving, however, a large outlay for apparatus. As now working this can be done only as demand for product develops. The field of activity could also be narrowed by dropping development work and confining efforts only to chemicals for which there is a paying demand.

The work is exceptionally dangerous and the risk unavoidable, as about 32 new preparations are started per month. New buildings are being erected to house the laboratory so as not to endanger the loss of the Eastman plant through fire or explosion. The author believes the ultimate success of the undertaking is assured if the products of the German chemists are not purchased.

Symposium on Refractories

Dr. **Miner** resigned the chair to A. V. **Bleininger**, who called attention to the many undetermined factors in the manufacture and application of refractories. These materials entering into the construction of furnaces of all sorts must be not only resistant to heat but also to mechanical shocks, heavy pressure and the scouring action of materials under treatment. The paper, "Classification of Refractories," by G. H. **Brown** was not presented but was said to contain a review of the different types from the high-grade flint clay brick, the silica and magnesite refractories down to the common fire clay brick.

Work of the Technical Department of the Refractories Manufacturers' Association—R. M. **Howe**. During May, 1917, the Manufacturers' Association established a fellowship at the University of Pittsburgh for research work on refractories. A laboratory was equipped and tests commenced on fire brick. Since that time the personnel has increased from one to five investigators and over 50 companies have been served. The organization is self-supporting and its mode of operation is such as to prevent a monopoly of the service by any one company. Some tests have been made on magnesite and silica.

The work has embraced mining selections by drill cores, analyses of same, together with investigations of mixtures and blends made up of brick bats, bauxite, silica, etc. Among other factors considered were temperature operation, water content, abrasive qualities and physical strength. It was found that an increase of water content increased the strength of the brick. Method of manufacture and drying depends on type of clay as regards its contraction characteristics. Performance of brick under service is also a part of the work.

The Selection of Refractories for Industrial Furnaces—W. F. **Rochow**. The chemical composition of a refractory material is not so important as heretofore considered, especially in many cases where the temperature is not of sufficient height to reach the point required for chemical reaction between the walls of the furnace and the material being treated. It is often better to use an acid brick with a basic material, or vice versa. An example of this is the use of silica brick in the glass industry.

Silica brick is found to be 25 per cent better than fire clay for by-product coke ovens due to its high thermal conductivity, mechanical strength and high fusing point. A more uniform temperature is secured in muffles due to the high thermal conductivity. Thermal expansion of silica brick occurs between 230 and 500 deg. C. and the heat must be carefully applied through this range. It is practically eliminated after the first burning. The mechanical strength is good at high tempertures. In arch construction it is insulated with kieselguhr. Long service of a brick in open-hearth furnaces shows four distinct strata with the lime stratum carried to the center of the brick and away from the heat.

Magnesite brick is not strong at high temperatures, and in order to remedy this feature a soft steel band or casing is built around blocks of dead burned magnesite for such work as gas ovens.

Interesting Facts Concerning Refractories in the Iron and Steel Industry—C. E. **Nesbitt** and M. L. **Bell**. Refractories are an important factor in the successful operations of the iron and steel industries. Good results will obtain if the producer of brick cooperates with the consumer, for the latter should know what the product must stand and the manufacturer must know the limitations of his product.

The range of temperature in the iron furnace varies from 260 deg. C. at the top to 1600 deg. C. at the tuyères. The chemical and physical properties should be known. Test conditions must be more severe than operating demands. Questions are raised by the tests given through the American Society of Testing Materials such as why the life of the same type of brick varies from 2 to 7 years or why converter bottoms last from two to six heats, and some of the individual bricks stand intact in these bottoms, while others are destroyed.

Simple tests should be evolved for use of the consumer so that quantity runs could be made. It has been evidenced, with a variation in temperature from 30 to 1350 deg. C. that the crushing strength is reduced 60 per cent, and that loss in open-hearth roofs have been 20 per cent with 261 heats due to fire cracks. The variation in chemical composition occurs when fumes penetrate the pores in open-hearth work. The method of manufacture has a pronounced effect on the qualities of clay brick.

Superior Refractories—R. C. PURDY. The vital importance of the electric furnace calls for adequate refractories. The electric industry needs them for high-tension insulators, spark plugs in aircraft, etc. New high-temperature alloys, new glasses, new by-products demand superior refractories. The manufacturer and consumer must co-operate in developing the particular refractory for the special requirement.

As an illustration of refractory failures, fire clay may be taken. It ranges from 100 per cent kaolinite to complex mixtures in composition. The fusion in the brick during manufacture should be carried only to the required point without distortion, and there the heat action should be arrested. This point is largely determined by physical evidence. Melting points are resolved into melting ranges when a mixture of minerals is involved. A 1600 deg. C. brick might be finished at 1000 deg. C.

The essential requirements in superior refractories are heavy loads at high temperatures, no chemical action, constant volume, resistance to abrasion and sudden temperature changes; and these are met by physical strength, high fusibility and low volume changes.

The classification as regards acid, basic or neutral brick is not important. The exceptions are small in number. The future superior refractory may come from fused alumina, carborundum and so-called rare earths providing the cost is not prohibitive. Little bonding material is to be used and then fusible substances or silicate of soda only.

Refractory Problems in the Gas Industry—W. H. FULWEILER and J. H. TAUSSIG. Coal gas retorts operate at 1000-1200 deg. C. in one type, 1400-1500 deg. C., and 1350-1500 deg. C. in another type. The temperature at the top of retorts is about 850 deg. C. The internal surfaces have variation in temperature due to filling with coal at 12-hr. intervals. Both silica and fire brick are used with an expansion of $\frac{3}{16}$ in. per ft. above 300 deg. C. and $\frac{1}{16}$ in. per ft. gradually to 1100 deg. C., respectively.

These expansions make the problem of construction a difficult one. Cast iron supports and double arches must be allowed for. The various parts are kept in line and slip joints are provided. A mixture of 96 per cent silica and 1½ to 2 per cent lime is used in one type cement, and 55 per cent silica and 45 per cent alumina in another bonding material.

Water gas is made in three steel brick-lined shells connected in series, brick checkerwork filling in the last two. The first or geneator shell operates at a temperature of 1700 deg. C. in the highest part, where fine coke particles form a clinker on the sides. Steam is admitted at the bottom. The chemical effect of the clinker is not important at the top, but it must be frequently pried away from the brickwork, causing abrasion. Dropping to the floor of the generator, it reaches a high temperature (1100 to 1700 deg. C.), and chemically attacks the floor and lower wall.

Fire brick is used in the second and third shells because silica will not stand the sudden temperature changes caused by dosing every 4 min. with cold oil.

Zircon and carborundum bricks stand up well for gas work, but the cost is thirty times that of other grades. The better cements used in construction, and consisting of brick binder with a small amount of fusible material, are hard for the mason to work, because of poor spreading qualities. These features of expense must be weighed against the final improvement to determine the advisability of their adoption.

Symposium on Annual Patent Renewal Fees with the Division of Pharmaceutical Chemistry and Section of Dye Industry

The division met on Friday morning with a number of the members of Pharmaceutical and Dye Divisions present and Dr. MINER vacated the chair for E. J. PRINDLE. The members were asked to confine their remarks strictly to the subject at hand, as time did not permit the discussion of the patent situation in general.

Dr. HESSE had previously proposed by letter that taxes be imposed on U. S. patents, beginning with the eighth year. Quotation of part of his letter is as follows:

"Our patent system is founded on the constitutional provision that 'Congress shall have power to promote the progress of science and the useful arts, by securing for limited times to authors and inventors, the exclusive rights to their writings and discoveries.' It seems to me only fair to assume, therefore, that Congress is not to grant these exclusive rights if by so doing 'progress of science and useful arts' is needlessly impeded or obstructed.

"An inventor who allows his patent to lie idle transgresses the spirit underlying the patent system. He is reserving to himself a field of endeavor which he has agreed to exploit and is not exploiting, and by his reservation he prevents the exploitation by others and thus retards progress.

"A possible remedy for this might be a low annual tax, say from $15 to $25, or some other sum not high enough to stand in the way of any inventions giving any reasonable promise of remuneration, yet high enough to make it appear unprofitable to retain reservations which inventors are either unwilling, unable or incompetent to develop.

"When a German inventor forfeits his German patent he thereby opens that field for development and exploitation by Germans in Germany, but because he does not also at the same time relinquish his corresponding rights in the United States, we are barred by our own laws and by our own acts from enjoying a liberty of action and a freedom of invention which the Germans enjoy. A dead German patent, therefore, still lives and rules in the United States.

"I am of the opinion that such a tax system as here proposed would effectively remove much of the grip which foreign and especially German patent inventors have on our domestic industry, and would also relieve us of the congestion due to patents of our own citizens which are not exploited or serve no useful purpose and to some extent, at any rate, of that class of domestic patentees designated, more or less unjustly perhaps, as patent sharks, trailers or pirates."

Mr. PRINDLE stated the following points in regard to Dr. HESSE'S proposal should be considered:

1. Is the principle of patent taxation a sound one?
2. Would taxes restrict pirates?
3. Would taxes restrict the poor inventor?
4. Would they liberate patents from corporation control?

5. Would a new field be opened up?
6. Would held patents be forfeited?
7. Should patents be free from taxation the first seven years, and if not for what period?
8. What size of fee should be charged and should it remain stationary or increase?

Dr. L. H. **BAEKELAND**. The subject has been debated before. The system of patent laws in the United States is theoretically the most liberal of all countries and has been held up as a model one. There is a difference between theory and practice, however, and it is really intricate and complicated, to the detriment of the inventor.

The purpose of taxation is to eliminate so-called paper patents, some of which are a hindrance. The tax in European countries is a pretext at revenue collection. Under their systems a good many patents lapse and hardship is worked on the poor and honest inventor. The large companies gladly pay these renewal fees and the lapsed patents are largely those owned by individuals, the very people who need encouragement. Paper patents are eliminated, it is true, but the beginner is penalized.

The recent hearings in Washington on the patent situation are full of minor details, detracting from the fundamental changes really involved in the proposed House bills. They should forget these unimportant features and stick to main issues.

Dr. C. E. K. **MEES**, Eastman Kodak Co., presenting a paper written by Mr. **STINCHFIELD**, the company's patent attorney. If we examine fundamentals we will see that the principal object of the patent grant is to promote public interest in invention. The Government gives the inventor a limited monopoly in exchange for the free public use of this discovery later. The fees charged are only to cover the expenses of the Patent Office, and taxes should not be added.

The proposed taxation would not be equitable because the Government cannot cancel a contract with the inventor where his discovery has been previously revealed. His secret cannot be recalled.

No good will be accomplished by elimination of paper patents, as they harm nobody. It is like shooting a corpse. The live patents would not be allowed to lapse. Incentive to invention would be smothered. The tax would not be strong enough to help the situation. The forfeiting of unworked patents in Europe also acts unfairly, where they are immediately grabbed, and in cases of old patents becoming suddenly valuable the originator reaps no reward for his ideas.

The public secures something for nothing. Taxes are an especially heavy burden on the poor inventor and small business concern. If more fees must be charged, let it be done with the view of getting an adequate Patent Office organization in this country.

Dr. L. V. **REDMAN**. A system of fees is not satisfactory, if we assume our present patent principles are sound, i.e., that the monopoly given will stimulate invention and discovery. The renewal fee proposed would be justified if it eliminated the existing evils, but it would not do so. What applies in foreign countries does not apply here, due to differences in conditions. As a measure of reciprocity it would not work.

We cannot expect to correct abuses by taxing legitimate corporations for practicing their patents. Is the method of taking out and holding patents an abuse? A patent is fundamentally intended to be a monopoly. These contingent patents are not an abuse, because they are taken out to provide protection against parallel ideas intended to destroy the monopoly enjoyed by the basic patent. Their existence saves endless litigation.

The accusation that corporations take out contingent patents and withhold using the improvement is an assertion and not a proved fact. They must manufacture the best possible product or competition would spring up. If the good ideas were suppressed, the company would decay.

The patent pirate ties up new industries by taking out accessory patents to complicate the original claims without any intent to manufacture on his own account. He should be eliminated. Accessory patents should be allowed to the original inventor. There should be not taxes for revenue only, i.e., on working patents.

The chairman asked Mr. **REDMAN** if he thought such discrimination could be made and he replied that it could be by providing that no tax be placed on basic patents. The chairman called attention to the impossibility of reading the inventor's mind or intentions. Mr. **REDMAN** replied it was not hard to point out the pirate practically, but as to legal possibilities he could not say.

Mr. J. M. **WEISS** stated that true commercial patents would not be harmed by the small fees proposed and asked if Dr. **BAEKELAND** might not be mistaken in his statement that the majority of lapsed patents in European countries were those of poor inventors. He further stated that the taxes would clear the field of old patents which unfairly restrict development, because at the time they were taken out the inventor was not considering the field now affected.

Dr. **BAEKELAND** replied that he had personal acquaintance with a great many poor inventors both here and in Europe to whom the so-called small fee was an important item, often causing the loss of patents.

Mr. E. J. **PRINDLE** temporarily relinquished the chair to speak in substance as follows:

"Does the tax promote or deter the purpose for which the patent laws were enacted? Its purpose was to benefit the public by inducing inventors to reveal their secret by giving them a monopoly for a limited time and then it belonged to the public, adding to the treasury of public knowledge.

"Ours was the first practical patent system and ability to invent was rapidly developed in the people. The great wealth of this country is based largely on this fact. This inventive ability is not an inherent trait in our people, the majority of whom are descended from European stock, but is a result of our patent system. We should therefore be careful to do nothing to impair this situation.

"I wish to state that I am quite as much opposed to Germany's peaceful penetration, and quite as desirous of seeing her prevented from using unfair methods as Dr. **HESSE** can be. We should, however, consider any such proposal in the light of all its reactions and its effectiveness to accomplish that purpose.

"Any amendment to our patent law should conform to its fundamental purpose, which is to secure the production of inventions. The assumption and the fact are that inventions would ordinarily not be produced, if it were not for the inducements of the monopoly provided by the patent system.

"The path which the inventor must travel before he can reap any return is already so difficult that many doubt that it is worth while to make inventions.

"The patent committee of the National Research Council has taken the position that the incentive of the inventor should be increased rather than diminished, and its report to that effect has been approved by this society, and by many scientific societies, and by several of the large trade organizations.

"The Supreme Court of the United States has decided that the patent law does not require the inventor to work his invention.

"The effect of the annual renewal would be to impose a burden which many individuals and corporations would hesitate to face. Many of the most important inventions have been made by comparatively poor inventors on their own financial resources. and if, after having gotten their patents, they would still have to pay a series of annual taxes totaling a possible $550, and which in no way aided the exploitation of the invention, many of them would undoubtedly not attempt to make these inventions. The possibility of overlooking to pay the renewal fees, and thus losing all the time and money put into the invention and patent and all hope of future return, would act as a deterrent not only to the inventor but to any purchaser as well.

"Annual renewal fees would work a discrimination in favor of the rich man and the corporation against the average inventor.

"Furthermore, I do not believe that the imposition of annual taxes upon our patents would materially alter the German advantage under our patents. If a German-owned American patent were valuable in suppressing competition here, the Germans would unhesitatingly pay the renewal fees, even if they were much larger than the proposed taxes. If, on the other hand, the patent were so unimportant that the Germans would permit it to lapse for failure to pay the renewal fee, it would be of no advantage to us to be free to use it, for we should not want to use it.

"To be worth while a remedy must be one which will not only effectively check the Germans, but one which will not at the same time injure us—and more than them. The proposed remedy is not such a one.

Mr. HOLMES of the U. S. Patent Office was called upon and agreed with Mr. PRINDLE'S remarks.

Dr. T. HART ANDERSON telegraphed that he did not advocate a change, but was in favor of taxing foreign patentees as a matter of reciprocity. The taxes would probably be paid by them, however, on important patents.

Dr. J. M. FRANCIS wrote he was at a loss as to how to consider Dr. Hesse's letter. A tremendous stake is involved and our laws are good. A change might involve a terrible loss. The principles are good, but the remedy of taxation is poor, being a serious handicap to the young inventor.

Prof. ELIHU THOMPSON wrote he was opposed to the idea of fees, because the system of the Patent Office would be complicated by their collection. When an inventor is ahead of his time he should receive his reward when the development of the field calls for the use of his patent. The duration of time required for development of a basic idea after its first inception is sometimes very long, as in the case of large apparatus, and the reward should not be lost to the inventor.

Dr. W. R. WHITNEY of the General Electric Co. wrote that he would attempt to care specially for the question of the unfair standing of foreign inventors rather than reduce the favors extended to the American inventors. He declared that everything should be done to encourage young men to train themselves to be inventors.

Dr. A. D. LITTLE wrote that the fees in Europe were an unmitigated nuisance and the system should not be adopted.

E. A. HILL of the U. S. Patent Office wrote that the officials in the Patent Office organization agreed the burden of proof rests on those who want a change in the laws. Why experiment with the unknown? He is opposed to the tax, but recommends support of patent bills now before Congress.

Dr. HARLAN S. MINER proposed a resolution recommending to Congress that House bills Nos. 5011, 7010 and 5012 of the 66th Congress, first session, relating to patents and originally introduced through the patent committee of the National Research Council, be passed by that body. The resolution was unanimously carried. It was then suggested that each member of the A. C. S. write personal letetrs to his own Representative and Senators and also to John I. Nolan asking that the bills in question be favorably voted upon.

Continuation of Papers

Tensile Strength of Glue—G. HOPP. Viscosity and jelly strength have been used in testing glue, but tensile strength and stretch when applied are what is really required. The method of gluing boards and then pulling has not been satisfactory, since results obtained by this method were not uniform.

The new tests made consisted in molding the glue in strips, placing on a tin or aluminum screen to dry, and machining down to dimension required with a tolerance of about 0.001 in. Samples were then pulled in a 500-kg. machine with the jaws carefully aligned. Some of the results were as follows:

Glue	Stretch, Per Cent	Tensile Strength. Lb.
No. 1	4½	13,240
No. 2	2	8,520
No. 3	2	7,600
No. 4	3½	11,570

These results are the average of a number of samples in each particular instance and the variation from the average was 1 to 3 per cent. The samples were kept under standard condition of temperature and humidity (75 deg. F. and 65 per cent humidity) until pulled. at room temperature. Complete test requires a maximum of five days.

Carbon Black—Its Properties and Uses—G. ST. J. PERROTT. An investigation of the carbon black industry has been undertaken by the Bureau of Mines as a result of economic issues brought up during the war. In the present process of manufacture carbon black is made by burning natural gas with an insufficient supply of air for complete combustion, collecting the liberated carbon on a metal surface. This process produces from ½ to 2 lb. per 1000 cu.ft. of gas or 1.5 to 6.5 per cent of the total carbon in the gas.

The process at first sight seems wasteful, but examination shows it is at any rate the only one in practical operation that produces carbon black suitable for the ink trade and rubber industry consumers, whose combined use is over 30,000,000 lb. annually. The whole situation appears to necessitate thorough investigation before any opinion can be given as to the wastefulness of the present process.

Accordingly the industry has been studied as to methods of manufacture and properties and uses of the finished product. Plants in Louisiana, Oklahoma and West Virginia have been investigated by Bureau engineers. Other processes of making carbon black have been investigated. The uses of carbon black have been studied with the idea of determining the properties of the product which users of carbon black demand and with an attempt at designating in which of these uses carbon black is essential and in which a substitute material might be employed. Microscopic and chemical analysis of a number of blacks has been made and test methods studied with a view to finding the reason for the very different behavior exhibited by different blacks, particularly as applied to the ink trade.

Adherent Rust as an Accelerator in the Corrosion of Iron and Steel—W. D. RICHARDSON. The experiments on which this paper is based lasted over a period of 1000 days and results were tabulated. If we look on corrosion as an electrolytic phenomenon, we then must consider iron as the anodes and the cathodes to be embraced in both the other substances in the metal, such as carbon and copper, and also outside substances lying on the surface of the metal. These latter take the form of oxygen, CO_2, oil, rust, etc.

Conclusion is that the dominant substance in the corrosion is oxygen. Hydrogen ions also play a part. Depolarizers consist of the rust and mill scale. the latter disappearing and leaving the rust to do the work. Clean iron surface is very sensitive to corrosion and the substance on its surface determines the speed with which it starts. Highly polished surfaces, being a coating of the pure metal smoothly spread over the pores and free from presence of internal impurities to act as cathodes, start to corrode very slowly. When clean without polish ferrite and carbon are present to start immediate electrolytic action.

Mill scale or rust over the surface stops the course of the corrosion. Under the rust is usually found a black film (Fe_3O_4), which assists in retarding the action. Oil or other substance acts in the same way.

Cast-iron plates 6 in. square and ⅛ in. thick. and steel plates $\frac{1}{16}$ in. thick were used in the tests. These were placed in distilled water at rest, in distilled water with air agitation, in 10 per cent brine solution at rest and a 10 per cent brine solution with air agitation. In some cases the plates were removed and dried at intervals.

The losses by rust in brine were less than in distilled water because a smooth coating was soon formed which stopped further action, while in distilled water the rust was porous and action continued. Cast metals corrode less rapidly than steel metals due to nature of rust formed.

In no instance does the chemical composition of the metal influence the starting of corrosion, which really depends on some external substance, undoubtedly oxygen. The rate of corrosion after the start is made depends entirely on physical structure of rust formed.

Some Properties of Commercial Silicate of Soda—J. G. VAIL. Ordinary window glass is made from sand, soda and lime, melted together in a furnace. If we leave out the lime and increase the proportion of soda, the furnace yields a product, silicate of soda, which looks exactly like glass. This may be dissolved in water by the aid of special apparatus. The solution is the syrupy liquid familiar to almost everyone as water-glass. It has long been used for preserving eggs. More lately it has been found to possess many of the properties of glue. It is a strong adhesive. It sets rapidly. It cannot mold or spoil, and it is very much cheaper than glue.

As wood from our forests becomes more and more scarce, paper boxes, instead of wooden ones, are being used for shipping containers, but paper is neither thick enough nor strong enough to build boxes for shipping canned goods, shoes, soap, or the thousand and one things that are carried every day by the railroads. So the sheets of paper have to be pasted together, three, four and sometimes five-ply, to make a strong, tough product. For this the mineral adhesive, silicate of soda, is universally employed. It sticks so quickly that the rolls of paper can pass through the pasting machine at 150 ft. per min., and the combined board can be cut into sheets and fashioned into boxes without waiting for the adhesive to dry. After filling, the boxes are sealed with silicate of soda.

The box industry is growing, but there are a great many other industrial uses for a material to stick things together. Silicate of soda, the mineral adhesive, is the cheapest and the best for many of these purposes. It was hardly known for adhesive purposes 10 years ago, and scientific study of its properties and how to make and use it are constantly showing more ways to apply it. Animal and vegetable products which can be used for food are thus conserved for their rightful use. This is genuine economy.

The Leaching of Zinc Chloride From Treated Wood—ERNEST BATEMAN. This paper covered a large number of tests made on various woods by treating with 1 per cent, 3 per cent and 5 per cent solutions of zinc chloride, allowing to dry 28 days and testing. Results show the Cl radical comes out, leaving an excess of zinc. Basic zinc salts do not prevent decay, the Cl radical must be present to form $ZnCl_2$, or the wood is not protected from decay. The $ZnCl_2$ treated tie can be used in climates having not over 40 in. of rainfall per annum.

In addition to those outlined above the remainder of the 27 papers were read. These papers were of equal merit in the work covered. Each author showed long preparation and careful thought on his particular assignment. With such continued application of the individual member and a co-ordination of these efforts by the able leaders, one may well hesitate to predict the high state at which the industry will arrive during the coming decade.

Excursions

On Thursday afternoon seventeen of the representative plants of Philadelphia opened their doors to the convention. The bleach department of the Dill & Collins paper mills is described elsewhere in this issue. An account of the trip through the Atlantic Refinery, Barrett's, Electric Storage Battery, Foerderer, Warner and Welsbach plants will be given in the next issue.

For those wishing to avail themselves of the historical features offered in the Philadelphia vicinity, excursions were arranged to visit the old Colonial Capitol buildings containing the Liberty Bell and many objects of interest. Valley Forge, the winter camp of Washington's army in its final struggle before victory over Cornwallis, was visited by those who had seen the national shrines located in the city.

Program of Exposition Week

Fifth National Exposition of Chemical Industries—American Electrochemical Society—American Institute of Mining & Metallurgical Engineers — Technical Association of the Pulp & Paper Industry—American Ceramic Society—American Steel Treaters' Society

Fifth National Exposition of Chemical Industries

Coliseum and First Regt. Armory

Monday, Sept. 22

12 M.

Opening of Exposition.

2 P.M.

Meeting American Institute Mining & Metallurgical Engineers at Congress Hotel.

8 P.M.

Opening addresses at Chemical Exposition Auditorium.

GOV. FRANK O. LOWDEN of Illinois will made the address of welcome.

CHARLES H. HERTY, chairman of advisory committee, will respond.

JOHN W. O'LEARY, president Metal Trades Association of Chicago, "The Relation of the Chemist to the Manufacturer."

HERBERT H. DOW, "How Long Does It Take to Develop a Laboratory Process Into a Dividend?"

9 P.M.

Motion pictures in Chemical Exposition Auditorium.

Tuesday, Sept. 23

8 A.M.

Departure of members of the American Institute Mining & Metallurgical Engineers and American Electrochemical Society making excursion to steel mills at Gary, Ind.

2 P.M.

Symposium on "America's Case in Chemistry," at Chemical Exposition Auditorium, with ELLWOOD HENDRICK, president Chemists' Club and consulting editor CHEM & MET. ENG., as chairman.

"Dyestuffs," by J. MERRITT MATTHEWS, editor *Color Trade Journal.*

"Chemical Porcelain," by HERMAN S. COORS, of Herold China & Pottery Co.

"Laboratory Supplies; Lamp-Blown Glassware and General Apparatus," by C. G. FISCHER, of Scientific Materials Co.

"Glassware," E. C. SULLIVAN, of the Corning Glass Works.

"Laboratory Supplies; Instruments of Precision," by J. M. ROBERTS, secretary Apparatus Makers' Association of U. S.

"Optical Glass," by HARVEY N. OTT, of Spencer Lens Co.

8 P.M.

Motion pictures in Chemical Exposition Auditorium: "History and Utilization of Coal."

Joint Technical Meeting of American Institute of Mining & Metallurgical Engineers and American Electrochemical Society, on subject of "Iron and Steel," at Congress Hotel.

Wednesday, Sept. 24

10 A.M.

Meeting at Chemical Exposition of American Electrochemical Society for reading and discussion of papers.

Registration and meeting at Chemical Exposition of Technical Association of Pulp & Paper Industry in Officers Room, First Regiment Armory.

Address of welcome.

Opening address by president.

Report of executive committee.

Report of secretary-treasurer.

Reports by standing committees.

Meeting at Chemical Exposition of American Ceramic Society.

2 P.M.

Joint technical session American Electrochemical Society with American Institute Mining & Metallurgical Engineers at Chemical Exposition Auditorium.

2:30 P.M.

Meeting at Chemical Exposition of American Ceramic Society resumed.

3:30 P.M.

Meeting at Chemical Exposition of Technical Association of Pulp & Paper Industry resumed.

6:30 P.M.

Dinner of Technical Association of Pulp & Paper Industry at Union League Club.

8 P. M.

Motion pictures in Chemical Exposition Auditorium.

Thursday, Sept. 25

9:30 A.M.

Meeting at Chemical Exposition of Technical Association of Pulp & Paper Industry; general business meeting.

10 A.M.

Meeting of American Electrochemical Society jointly with American Institute of Mining & Metallurgical Engineers. Symposium on "Pyrometry" at Congress Hotel.

12 M.

Technical Association Pulp & Paper Industry adjournment for luncheon at, and as guests of, Sears, Roebuck & Co., to be followed by visit to the paper mill plant.

2 P.M.

Meeting at Chemical Exposition Auditorium.

"The Organization and Plans of the National Research Council With Special Reference to the Industries," H. E. HOWE, National Research Council.

"Fields for Industrial Development, Canadian National Railways," PRICE GREEN, Industrial Commissioner, Canadian National Railways.

"Filtration," HENRY B. FABER, Industrial Filtration Corp.

"Destructive Distillation Bituminous Material with Reduced Vapor Tension and Complete Temperature Control," THOMAS W. PRITCHARD, vice-president Fuel Products Corp.

4 P.M.

Committee meetings Technical Association Pulp & Paper Industry at Chemical Exposition.

8 P.M.

Motion pictures at Chemical Exposition.

8 P.M.

American Electrochemical Society smoker at Congress Hotel.

8:30 P.M.

Technical Association Pulp & Paper Industry smoker.

Friday, Sept. 26

Technical Association Pulp & Paper Industry will visit Forest Products Laboratory at Madison, Wis.

9:30 A.M.

Meeting of American Electrochemical Society at Chemical Exposition Auditorium. Subject: Symposium on "Catalysis."

2 P.M.

Meeting of American Electrochemical Society resumed.

8 P.M.

Motion pictures. JAM HANDY, vice-president Bray Studios, address, "Art Exposes the Invisible in Chemistry," during the showing of special films.

"Natural Resources on C. N. Ry." PRICE GREEN, Industrial Commissioner of Canadian National Railways, address during showing stereopticon and motion pictures.

8 P.M.

Award of Willard Gibbs Medal to Prof. W. A. NOYES, University of Illinois, by Chicago Section of American Chemical Society.

Saturday, Sept. 27

9:30 A.M.

Meeting at Chemical Exposition headquarters of Technical Association of Pulp & Paper Industry for adjourned business session in auditorium.

AFTERNOON

Technical Association Pulp & Paper Industry official visits of inspection to exhibits at Chemical Exposition.

2 P.M.

Meeting at Chemical Exposition Auditorium. Symposium on Safety in Plant and Mine under chairmanship of M. F. LEOPOLD, safety engineer, U. S. Bureau of Mines.

8 P.M.

Motion pictures, depicting safety work in the plant and mine, by courtesy of U. S. Bureau of Mines.

American Electrochemical Society

Monday, Sept. 22

6 P.M.

Registration begins at headquarters, Congress Hotel. Society headquarters at Exposition in booths 235-236 on balcony of Coliseum.

Tuesday, Sept. 23

All-day excursion by boat with the American Institute of Mining & Metallurgical Engineers to Gary, Indiana, and trip through the United States Steel Co. plant. Details about tickets at the registration desk.

10 A.M.

Meeting of Directors.

12 M.

Luncheon at Steel plant.

1:30 P.M.

Inspection of United States Steel Co's plant.

Joint technical session with the A. I. M. & M. E. General subject: "Iron and Steel."

8 P.M.

Joint technical session with the A. I. M. & M. E. at the Congress Hotel (continued).

Wednesday, Sept. 24

10 A.M.

Reading and discussion of papers at Chemical Exposition Auditorium.

"Manganin," M. A. HUNTER and J. W. BACON.

"The Activation of Carbon," N. K. CHANEY.

"Depreciation in Small Dry Cells With Age," A. J. HELFRECHT.

"The Effect of Amalgamation Upon the Single Potential of Aluminum," LOUIS KAHLENBERG and JOHN A. MONTGOMERY.

"The Effect of Amalgamation Upon the Single Potential of the Binary Alloys of Al With Cu, Zn and Ni," LOUIS KAHLENBERG and JOHN A. MONTGOMERY.

2 P.M.

Joint technical session with the A. I. M. & M. E. at Chemical Exposition Auditorium. General subject: "Ferrous and Non-Ferrous Metallurgy."

"Radiant Resistor Furnace," F. A. J. FITZGERALD.

"Electric Heat in the Typewriter Industry," A. M. CLARK.

"Electric Furnace for Experimental Work," F. A. J. FITZGERALD.

"A Square Deal for the Electric Furnace," H. G. WEIDENTHAL.

(See also papers for this session on the program of the A. I. M. & M. E.)

EVENING

Inspection of the electric furnace exhibits at the Exposition.

8 P.M.

Motion pictures in Exposition auditorium.

Thursday, Sept. 25

10 A.M.

Joint technical session with A. I. M. & M. E. Symposium on Pyrometry at Congress Hotel.

2:30 P.M.

Continuation of joint session.

8 P.M.

Complimentary smoker at Congress Hotel, tickets of admission to be obtained from the registrar.

Friday, Sept. 26

Symposium on Catalysis at the Chemical Exposition Auditorium.

"Some Problems in Contact Catalysis," **W. D. Bancroft.**

"Further Problems in Contact Catalysis," **H. S. Taylor.**

"The Thermal Problem in Organic Contact Catalysis," **W. J. Huff.**

"Thermal Problem in the Contact Process of Sulphuric Acid Manufacture," **F. C. Zeisberg.**

"Modern Theories of Matter and the Problem of Catalysis," **E. K. Rideal.**

2:30 P.M.

Meeting at Exposition Auditorium.

"Demonstration of Manufacture of Fluorine," **F. C. Mather** and **Burr Humiston.**

"Factors Governing the Structure of Electrodeposited Metals," **William Blum.**

"Lead Plating From Fluoborate Solutions," **William Blum, F. J. Liscomb, Zalia Jenks** and **W. E. Baily.**

"Commercial Possibilities in Electrochemical Production of Organic Compounds," **C. J. Thatcher.**

American Institute of Mining and Metallurgical Engineers

Monday, Sept. 22

MORNING

Registration begins at headquarters, Congress Hotel.

11 A.M.

Technical Sessions:

1. Session on Non-Ferrous Metallurgy and Metallography.

The papers will be read here by title only to afford opportunity for discussion when presented at the Philadelphia meeting of the Institute of Metals Division.

2. Session on Coal and Gas.

2 P.M.

Technical Sessions:

1. Session on Coal and Gas.
2. Session on Geology.
3. Session on Milling.
4. Session on Industrial Organization.

EVENING

Smoker.

Tuesday, Sept. 23

MORNING AND AFTERNOON

Excursion by boat with the American Electrochemical Society to Gary, Ind., and trip through the United States Steel Co. plant. During the afternoon upon the return trip, on the boat, technical session on Iron and Steel, jointly with American Electrochemical Society.

"Blast-Furnace Refractories," **Raymond M. Howe.**

"Effervescing Steel," **Henry D. Hibbard.**

"Aircraft Steels," **Albert Sauveur.**

"Determining Gases in Steel and the Deoxidation of Steel," **J. R. Cain.**

"Effect of Time and Low Temperature on Physical Properties of Medium-Carbon Steel," **G. A. Reinhardt** and **H. L. Cutler.**

"Erosion Tests of Rifle Barrels," **A. E. Bellis.**

"Metallography of Rifle-Barrel Steel," **G. F. Butterworth.**

8 P.M.

Session on Iron and Steel, jointly with American Electrochemical Society (continued):

"Industries of the Chicago District," **T. W. Robinson,** lantern slides, etc.

"Manufacture of Steel Rails," **Robert W. Hunt.**

"240-inch Plate Mill," **C. L. Huston.**

8 P.M.

Session on Oil:

"Irvine Oil District, Kentucky," **Stuart St. Clair.**

"Petroliferous Provinces," **E. G. Woodruff.**

"Investigations Concerning Oil-Water Emulsion," **A. W. McCoy, H. R. Shidel** and **E. A. Trager.**

"Essential Factors in the Valuation of Oil Properties," **Carl H. Beal.**

"Application of Law of Equal Expectations to Oil Production in California," **Carl H. Beal** and **E. D. Nolan.**

"Value of American Oil Shales," **Charles Baskerville.**

Wednesday, Sept. 24

10 A.M.

Technical Sessions:

1. Session on Iron and Steel:

"Cooling Properties of Technical Quenching Liquids," **N. B. Pilling** and **T. D. Lynch.**

"Differential Crystallization in Cast-Steel Runner." **Francis B. Foley.**

"Manufacture and Properties of Light Wall Structural Tubing," **H. J. French.**

"Oxygen in Cast Iron and Its Application," **Wilford L. Stork.**

"Graphitization of White Cast Iron Upon Annealing," **Paul D. Merica** and **L. J. Gurevich.**

"Experimental Data Obtained on Charpy Impact Machine," **F. C. Langenberg.**

"Heat Treatment of Cast Steel," **John H. Hall. Arvid E. Nisson** and **Knox Taylor.**

2. Mining and Local Resources:

"Winconsin Zinc District," **W. F. Boericke** and **T. H. Garnet.**

"Mineral Resources of the La Salle District," **J. A. Ede.**

"New Angles to the Apex Law," **John A. Shelton.**

"Mining Methods of Alaska Gastineau Mining Co.," G. T. JACKSON.

"Tunnel Driving at Copper Mountain, B. C." (Columbia Section Paper), OSCAR LACHMUND.

"Geology and Mining Methods at Pilares Mine," ALFRED WANTKE, W. ROGERS WADE.

"Wedging Diamond-drill Holes," O. HALL and V. P. ROW.

3. Session on Sulphur in Coal:

"Geographic Distribution of Sulphur in the West Virginia Coal Beds," I. C. WHITE.

"Occurence and Origin of Finely Desseminated Sulphur Compounds in Coal," RHEINHARDT THIESSEN.

"Mechanical Separation of Sulphur Minerals From Coal," J. R. CAMPBELL.

"Sulphur in Coal—Geological Aspects," GEORGE H. ASHLEY.

"Forms in Which Sulphur Occurs in Coal," A. R. POWELL.

"Effect of Sulphur in Coal Used in Ceramic Industries," C. W. PARMELEE.

2 P.M.

Technical Sessions:

1. Session on Non-Ferrous Metallurgy, jointly with American Electrochemical Society at Chemical Exposition Auditorium:

"Electric-Resistance Furnace of Large Capacity for Zinc Ores," CHARLES H. FULTON.

"Water and Chlorides in Cement Copper," EDWARD KELLER.

"Chemical and Electrochemical Problems Involved in the New Cornelia Copper Co.'s Leaching Process," HENRY S. MACKAY.

"Electrolytic Zinc," C. A. HANSEN.

"Treating Antimony Ores," GEORGE P. HULST.

2. Session on Sulphur in Coal:

"Removal of Sulphur From Illuminating Gas," W. W. ODELL and W. A. DUNKLEY.

"Low Sulphur in Coal," H. M. and T. M. CHANCE.

"Low-Sulphur Coals of Kentucky," WILLARD R. JILLSON.

"Low-Sulphur Coal in Illinois," GILBERT H. CADY.

"Sulphur in the Coking Process," S. W. PARR.

"Commercial Recovery of Pyrite from Coal," S. H. DAVIS.

"Sulphur in Producer Gas," FREDERICK CRABTREE and A. R. POWELL.

3. Session on Pyrometry With Special Reference to Iron and Steel Metallurgy:

Report of the Pyrometer Committee of National Research Council, George K. Burgess.

"Pyrometry in Blast-Furnace Work," P. H. ROYSTER and T. L. JOSEPH.

"Pyrometry and Steel Manufacture," A. H. MILLER.

"Electric Open Hearth and Bessemer Steel Temperatures," F. E. BASH.

"Some Thermal Relations in the Treatment of Steel," CHARLES F. BRUSH.

"Pyrometry in the Tool Manufacturing Industry," J. V. EMMONS.

"Forging Temperatures and Rate of Heating and Cooling of Large Ingots," F. E. BASH.

Evening

Banquet at Congress Hotel.

Thursday, Sept. 25

10 A.M.

Optional excursion to De Pue, Ill., by train for inspection of zinc smelters, cement works and coal mines.

Trip to Starved Rock and points of historical interest.

10 A.M. and 2 P.M.

Technical meeting, subject: Symposium on Pyrometry, jointly with American Electrochemical Society:

"Temperature," J. S. AMES.

"Standard Scale of Temperature," C. W. WAIDNER, E. F. MUELLER and PAUL D. FOOTE.

"Metals for Pyrometer Standardization," C. W. WAIDNER and GEORGE K. BURGESS.

"Fundamentals of Pyrometry," C. E. MENDENHALL.

"Thermo-electric Pyrometry," PAUL D. FOOTE, T. R. HARRISON and C. O. FAIRCHILD.

"Potentiometers for Thermo-element Work," WALTER P. WHITE.

"Self-Checking Galvanometer Pyrometer," H. F. PORTER.

"Some Factors Affecting the Use of Base-Metal Thermocouples, O. L. KOWALKE.

"Curves and Tables to Represent the Relation Between Thermal E.M.F. and Temperature," L. H. ADAMS.

"Reference Standard for Base-Metal Thermocouples," N. E. BONN.

"Alloys Suitable for Thermocouples and Base-Metal Thermo-electric Practice," J. M. LOHR.

"Recent Improvements in Pyrometry," R. P. BROWN.

"Automatic Correction for Temperature of Cold Junctions," F. WUNSCH.

"A Hot Wire Anemometer With Thermocouple," T. S. TAYLOR.

"Porcelain for Pyrometric Purposes," F. H. RIDDLE.

"Pyrometer Porcelain and Refractories," R. W. NEWCOMB.

"Porcelain Pyrometer Protecting Tubes," F. A. HARVEY.

"Porcelain Tubes for Thermocouples," R. B. LINCOLN.

"Melting Point for Refractory Materials," LEO I. DANA.

"High Temperature Scale and Its Application in the Measurement of True Brightness and Color Temperature," EDWARD P. HYDE.

"Theory and Accuracy in Optical Pyrometry," W. E. FORSYTHE.

"Optical and Radiation Pyrometry," PAUL D. FOOTE and C. O. FAIRCHILD.

"Industrial Application of the Disappearing-Filament Type of Optical Pyrometers," F. E. BASH.

"Use of the Optical Pyrometer for Control of Optical-Glass Furnaces," C. N. FENNER.

"Emissive Powers and Temperatures of Non-Black Bodies," A. G. WORTHING.

"Recording Thermocouple Pyrometers," LEO BEHR.

"Recording Pyrometry," C. O. FAIRCHILD and PAUL D. FOOTE.

"A Remote Control Valve Operating Mechanism for Hand or Automatic Control," R. W. NEWCOMB and C. ENGLEHARD.

"High Temperature Control," C. O. FAIRCHILD and PAUL D. FOOTE.

"Resistance Thermometry," F. W. ROBINSON.

"Tin an Ideal Pyrometric Material," E. F. NORTHRUP.

"Resistance Thermometry for Industrial Use," CHARLES P. FREY.

"Temperature Measurement in Optical Glass Annealing Furnaces," E. D. WILLIAMSON and H. S. ROBERTS.

"Annealing of Glass," A. Q. TOOL and J. VALASEK.

"Pyrometry Applied to Bottle-Glass Manufacture," R. L. FRINK.

"Pyrometry in the Manufacture of Optical Glass," ALBERT J. WOLCOTT.

"Pyrometry as Applied to the Manufacture of Optical Glass," CARL W. KEUFFEL.

"Pyrometer Shortcomings in Glass-House Practice," W. M. CLARK and CHARLES D. SPENCER.

"Temperature in the Manufacture of Pottery," F. K. PENCE.

"Pyrometry in the Chemical Industry as Applied to Gas Mask Manufacture," K. MARSH.

"Application of Pyrometry to the Ceramic Industries," C. B. THWING.

"Pyrometry in Rotary Portland Cement Kilns," by LEO I. DANA and C. O. FAIRCHILD.

"Application of Pyrometers to Ceramic Industry," JOHN P. GOHEEN.

"Temperatures of Incandescent Lamp Filaments," BENJAMIN E. SHACKLEFORD.

"Temperature Measurements of Incandescent Gas Mantles," H. E. IVES.

"Application of Pyrometry to Problems of Lamp Desire and Performance," I. H. VAN HORN.

"Use of Modified Rosenhain Furnace for Thermal Analysis," H. SCOTT and J. R. FREEMAN.

"High Temperature Thermometers," R. M. WILHELM.

"Temperature of a Burning Cigar," T. S. SLIGH and C. S. KRAYBILL.

"Teaching Pyrometry in Our Technical Schools," GEORGE V. WENDELL.

"Teaching Pyrometry," C. E. MENDENHALL.

"Teaching Pyrometry," O. L. KOWALKE.

"Present Status of Radiation Constants," W. W. COBLENTZ.

"Pyrometer Protection Tubes," OTIS HUTCHINS.

Friday, Sept. 26

Continuation of adjourned Technical Sessions:

MORNING

Optional Trips.

1. North Chicago and Milwaukee.
2. East Chicago metallurgical plants and oil refineries at Whiting, Indiana.
3. Local Chicago plants.
4. Coal trip to Franklin and Macoupin counties.

Technical Association of the Pulp and Paper Industry

The following tentative program of meetings, excursions and entertainments of the Technical Association of the Pulp & Paper Industry, Chicago, has been prepared. More extensive details appear in the final program.

Sept. 24, 25, 26 and 27—All meetings are to be held in conjunction with the Fifth National Exposition of Chemical Industries in the officers' Board Room of the First Regiment Armory, Sixteenth St. and Michigan Boulevard, and at the Coliseum, Wabash Ave. and Fifteenth St., Chicago. Admission by T. A. P. P. I. badge. Members are requested to register at T. A. P. P. I. booth, No. 237, and at the entrance to the Armory, immediately on arrival any time during the week.

Wednesday, Sept. 24

10 A.M.

Opening meeting in First Regiment Armory.

Address of welcome.

Opening remarks by the president.

Report of the executive committee.

Report of the secretary-treasurer, followed by reports of standing committees:

Abstracts of Literature, ROSS CAMPBELL, chairman.

Bibliography, HENRY E. SURFACE, chairman.

Heat, Light and Power, EDWARD P. GLEASON, chairman.

Paper Testing, FREDERICK C. CLARK, chairman.

Soda Pulp, MARTIN L. GRIFFIN, chairman.

Standard Methods of Testing Materials Used in the Manufacture of Paper, WILLIAM H. GESELL, chairman.

Sulphate Pulp, OLAI BACHE-WIIG, chairman.

Sulphite Pulp, HERBERT G. SPEAR, chairman.

Vocational Education, GEORGE E. WILLIAMSON, chairman.

Among the special papers and reports to be presented and discussed is one entitled "The Principles and Practice Involved in Washing Unbleached Soda Pulp." This will form the report of the committee on Soda Pulp, MARTIN L. GRIFFIN, chairman.

The committee on Sulphate Pulp, O. BACHE-WIIG, chairman, will make a report on tests which have been made to determine the loss of soda in the evaporation of black liquor in sulphate mills. The report is not expected to be a lengthy one, but it will be characterized by great accuracy, the tests having been made by the same chemists in a number of different pulp mills. Methods of overcoming avoidable waste will be described in the report.

The committee on Paper Testing, FREDERICK C. CLARK, chairman, promises a revised report on methods of testing paper which should prove of great interest and value.

3:30 P.M.

Adjourned session in First Regiment Armory.

The committee on Sulphite Pulp will report on new methods of handling waste liquor from digesters and of cooling the SO_2 gas from burners.

An account of research work on the important problem of waste sulphite liquor utilization will be presented by Prof. RALPH H. MCKEE and GEORGE BARSKY, of Columbia University, in a paper entitled "Fuel From Waste Sulphite Liquor."

6:30 P.M.

Dinner at the Union League Club.

Thursday, Sept. 25

9:30 A.M.

Business meeting at Registration Booth in Coliseum.

1 P.M.

Adjournment for visit to paper mill plant of Sears, Roebuck & Co.; luncheon as guests of the firm.

2 P.M.

Inspection tour of the Sears, Roebuck & Co., plant.

4 P.M.

Committee meetings and special papers.

7 P.M.

Illustrated address by Dr. R. J. **Blair**, pathologist, Forest Products Laboratories of Canada, McGill University, Montreal, on "Prevention of Decay in the Timber of the Roofs of Pulp and Paper Mills," followed by smoker and entertainment.

Friday, Sept. 26

The day will be spent in a visit of inspection to the Forest Products Laboratory of the Forest Service, U. S. Department of Agriculture, Madison, Wis. Train arrangements provide for members taking a late train from Chicago on Thursday evening and arriving in Madison early Friday morning, or leaving late in the afternoon so as to reach Madison shortly after 9 o'clock in the evening. Hotel accommodations at Park Hotel. The departure from Madison will be made on Friday at 5:40 P. M., arriving in Chicago at 10:30 P.M. The first class fare from Chicago to Madison is $4.21, and sleeper berth $1.60. Notice of intention to take the trip should be sent promptly to Chairman Savery.

Saturday, Sept. 27

9:30 A.M.

Adjourned business sessions at the National Exposition of Chemical Industries.

American Ceramic Society

Program for "Ceramic Day" at the Fifth National Exposition of Chemical Industries, the Coliseum, Chicago, Sept. 24, 1919.

10 A.M.

"The American Ceramic Society, Past, Present and Future," Prof. **Charles** F. **Binns**.

"Buy on Analysis," Dr. **Alexander Silverman**.

"Superior Refractories," **Ross** C. **Purdy**.

"The Making of Pottery," **Frederick** H. **Rhead**.

2:30 P.M.

"General Types of Optical Glass," **Robert** J. **Montgomery**.

"Brick and Tile," **Douglas** F. **Stevens**.

"The Application of Scientific Methods to Ceramic Research," A. V. **Bleininger**.

"The Manufacture of Optical Glass," Dr. J. C. **Hostetter**.

"Enameling Technology," R. R. **Danielson**.

Other addresses will be delivered at both morning and afternoon sessions.

8 P.M.

Motion pictures, including:

1. "Making Cut Glass."
2. "Glass Bulb and Tubing Manufacture for Mazda Lamps."
3. "Making Window Glass."

BANQUET

It is urged that all members and their friends attend the dinner at 6 P.M., New Southern Hotel, 1250 South Michigan Ave., very near the Coliseum. Tickets at $2 each can be secured at the Society's booth, No. 229, during the day, Sept. 24.

HEADQUARTERS

The headquarters of the American Ceramic Society throughout the Exposition week will be at Booth 229, at which representatives of the Society will be in constant attendance. It is urged that all members make their headquarters at the booth and everyone who is any way interested in the silicate industries will be most welcome. Any information which can be gotten for the assistance of any visitor will be obtained. At the booth there will be literature regarding the ceramic industry and the American Ceramic Society.

American Steel Treaters' Society

Tuesday, Sept. 23

9 A.M.

Registration Seventh Regiment Armory.

10 A.M.

Address of welcome: Hon. **Harry** H. **Merrick**, president Chicago Association of Commerce.

Address of welcome: Acting President T. E. **Barker**.

Report of Acting Board of Directors by Acting Secretary A. G. **Henry**.

Report of Finance Committee: Acting Chairman A. F. **Boissoneau**.

Paper: "Relation of Heat Treatment, Design and Selection of Steels for Metal Cutting Tools to Factory Production; C. P. **Berg**, president C. P. Berg & Co., consulting engineers.

Visit to Exhibits.

2 to 4:30 P.M.

Presiding officer, **Horace** H. **Clark**, chairman Chicago Chapter.

2 P.M.

Report of tellers of election. Adress of president-elect.

Papers: "Heat Treatment of Steels for Cutting Purposes."

8-10 P.M.

Presiding officer, G. **Walter Esau**, chairman Milwaukee Chapter. Papers: "Case Hardening in General."

Wednesday, Sept. 24

10-12 A.M.

Presiding officer, **David Bell**, chairman Buffalo Chapter. Papers: "Heat Treatment of Miscellaneous Products."

2-4 P.M.

Presiding officer, B. F. **Weston**, chairman Pittsburgh Chapter. Papers: "Heat Treatment of Steel for Intermittent Cutting Purposes."

8-10 P.M.

Presiding officer, **George** W. **Pressell**, chairman Philadelphia Chapter. Papers: "Results of Investigation Pertaining to Heat Treatment."

Thursday, Sept. 25

10-12 A.M.

Presiding officer, W. S. Biddle, chairman Cleveland Chapter. Papers: "Heat-Treating Equipment."

2-4:30 P.M.

Presiding officer, Frank P. Fahy, chairman New York Chapter. Papers: "Solution of Modern Demands on Heat Treating."

6:30 P.M. Sharp

Informal banquet and entertainment, Cameo Room, Morrison Hotel. Tickets $3.

Friday, Sept. 26

10 A.M.

Exhibit at Seventh Regiment Armory. Plant visitation.

7-10 P.M.

Band concert. Third Regiment Military Band.

Saturday, Sept. 27

"Chicago Day."

Exhibition open 10 A.M.-10 P.M.

1:30 P.M. and 7 P.M.

Band Concert. Third Regiment Military Band.

The Papers

An extensive list of papers, covering the very latest developments in every field of the heat-treating art, has been prepared. The papers given below form but a small part of the completed program:

"Modern Pyrometry," A. W. Anderson, C. S. Gordon Co.

"Metallography of Steel," Cyril J. Atkinson, Laboratories, Milwaukee, Wis.

"Annealing Large Sections of Cast Nickel Steel," G. A. Brewster, American Steel Foundries, Chicago, Ill.

"Salts for Quenching," Shipley N. Brayshaw, London, England.

"Relation of Heat Treatment, Design and Selection of Steels for Metal Cutting Tools to Factory Production," C. P. Berg, C. P. Berg & Co., Chicago, Ill.

"Results of Investigations Pertaining to Heat Treating," Ray T. Bayless, James H. Herron Co., Cleveland, Ohio.

"Pyrometry," R. P. Brown, president Brown Instrument Co., Philadelphia, Pa.

"Cast Steel," Alvin N. Conarroe, chemist and metallurgist, National Malleable Castings Co.

"Electric Heating of Steel," E. F. Collins, General Electric Co.

"Case Hardening in General," William G. Conner, George D. Whitcomb Manufacturing Co., Rochelle, Ill.

"Heat Treatment of Balls for Bearings," Arthur L. Collins, Atlas Ball Co., Philadelphia.

"Effects of Forging Temperatures on Heat Treatment of Steels," D. R. Cornell, Standard Forgings Co., Indiana Harbor, Ind.

"Heat Treatment of Cast Steel," William George Dauncey, Associate Editor, *Iron and Steel*, Montreal, Canada.

"Heat Treatment of Cast Steel in Tractor Construction," Fred Grotts, Holt Manufacturing Co., Peoria, Ill.

Chicago Exhibitors

The following societies and publications will have booths, in which they will be glad to receive their friends:

American Ceramic Society.
American Chemical Society.
American Dyes Institute.
American Electrochemical Society.
Canadian Chemical Journal.
Canadian Mining Journal.
Canadian Textile Journal
Chemical Catalogue Co, Inc.
Chemical & Metallurgical Engineering.
Chemical Engineer.
Chicago Section, American Chemical Society.
Color Trade Journal.
Industrial & Educational Press.
Iron & Steel of Canada.
Journal of Commerce.
Journal of Industrial and Engineering Chemistry.
McGraw-Hill Co.
Manufacturers' Record.
Oil, Paint & Drug Reporter.
Paper.
Pulp & Paper Magazine of Canada.
Technical Association of the Pulp & Paper Industry.
Textile Colorist.

The names of the representatives and brief itemization of products of the exhibitors are given as received up to the closing date of this issue. Over 330 firms are taking advantage of the excellent opportunity offered in the Chicago Exposition to extend their acquaintance in the Central States.

Paul O. Abbe—Crushing, cutting, pulverizing, disintegrating, mixing and sifting machinery. Special features—motor-driven, self-contained unit jar and pebble mills, Gruendler hammer mills, Mead mills, etc. In charge of exhibit: Paul O. Abbe, Henry Sellman and John Buckley.

Abbe Engineering Co.—Pebble mills, disintegrators, Max mills, bolting cloth, featuring motor-driven laboratory mills. In charge of exhibit: H. F. Kleinfeldt and W. S. Ransom.

The Abbott Laboratories—Synthetic pharmaceuticals, such as barbital, chlorazene, chlorcosane, dichloramine-T, histidine, calcium, copper, mercury, sodium and zinc phenolsulphonates, etc. The features of the exhibit will be a working model of the manufacture of chlorazene from coal tar, and a physiologic testing demonstration of anesthetics and hypnotics. In charge of exhibit: W. F. Straub, E. H. Vollweiler, Carl Nielsen and Norman Hansen.

William Ainsworth & Sons.—Three analytical balances. In charge of exhibit: A. W. Ainsworth.

Albany Felt Co.—A complete line of all wool-woven filter cloths for the various methods of filtration. These cloths work most successfully in aniline dye plants and also in plants manufacturing the heavier chemicals. There will also be samples of paper mill felts used by manufacturers of newsprint, bonds, writings, tissues, boards and pulps. In charge of exhibit: Walter S. Rooney.

The Alberene Stone Co.—Various laboratory equipment including a standard hood, consisting of a complete superstructure of Alberene stone and wireglass with sliding sash, work-tables, reagent shelves and a chemical sink with drainboard and pegboard for washing and drying glassware. A special photograph tank for X-ray purposes will be found of interest to physicians and others interested in X-ray work. In charge of exhibit: Warren K. Fields, F. A. Buss.

Allen Electrolytic Corp

American Ballast Co. (formerly the American Limestone Co.)—Various kinds of limestone in various conditions of preparation from a sample of rock down to ground material, which will be 200-mesh in fineness. In charge of exhibit: Scott A. Fones.

American Chemical & Manufacturing Co.—"Hippo" waterproofing products, including acid, water and shower proof textiles; waterproof concrete, concrete floor hardener; acid-proof, oil-proof, brine-proof coatings for steel; lacquers for food tins, etc.; insulating varnishes for transformer coils; wall primer to prevent leaching of calcium salts. In charge of exhibit: Charles D. Stillman, W. M. Van Ostrom and R. C. Dederick.

American Cyanamid Co.—The principal features will be a series of models accompanied by brief descriptive matter showing the process of fixing nitrogen from the air in the form of cyanamide together with samples of all cyanamide products, with brief descriptions of their principal uses. In charge of exhibit: E. J. Pranke and J. P. Hubbell.

American Hard Rubber Co.—An electrically driven hard rubber centrifugal pump, pumping through a hard rubber pipe into hard rubber tanks. The only material which comes in contact with the liquid is hard rubber. Small reciprocating pumps and other articles will illustrate the various uses to which hard rubber can be put. In charge of exhibit: A. M. Ackerman and E. D. Madden.

American Kron Scale Co.—One of the standard portable scales of the type adopted by the American Railway Express Co. will be exhibited to demonstrate claims as to durability and strength. In charge of exhibit: Carl F. Larson and John M. Bjornson.

American La France Fire Engine Co.

American Metal Products Co. "Ampco" metal, both castings and sheet, including valves, calorimeter bombs, runners, liners, etc. designed to resist the corrosive action of all commercial acids. In charge of exhibit: H. C. Brelie, Miss E. T. Smith, R. W. Alger and C. J. Zaiser.

American Meter Co.—A No. 302 calorimeter set, new type of cubic foot standard as described in technologic paper No. 114 of Bureau of Standards, a $\frac{1}{10}$-cu.ft. bottle, set of gages, specific gravity apparatus, service cleaner, and various types of test meters. In charge of exhibit: H. D. Harper and J. G. Barrett.

American Rolling Mill Co.

American Transmarine Co.

American Water Softener Co.

Anaconda Copper Mining Co.—(See Raritan Copper Works).

H. Reeve Angel & Co.—Whatman filter papers, including two new products, viz: Strips for arsenic determinations and absorption blocks. Filter papers of American manufacture, including the Alpha No. 190, Lion, Griffin Gray and Climax brands. "Labruco" pure gum rubber tubing, filter mass, glass wool, etc. In charge of exhibit: Byron S. Proper.

Aniline Dyes & Chemicals, Inc.

Arkell Safety Bag Co.—Linings for shipping packages such as barrels, boxes, drums and bags. The linings will be shown inserted into the different packages ready for use. In charge of exhibit: P. J. Morales and John B. Judson, Jr.

Armstrong Cork Co.—Insulating material for hot and cold surfaces; nonpareil corkboard insulation for refrigerated and constant temperature rooms, nonpareil cork covering for cold pipes and tanks, nonpareil insulating brick for furnaces and other high temperature equipment. The feature will be an electrically heated furnace so arranged as to give a tangible demonstration of the difference in the heat-conducting qualities of nonpareil brick and ordinary brick. In charge of exhibit: S. L. Barnes.

Arnold, Hoffman & Co., Inc.—A joint exhibit with the Mathieson Alkali Works and the Nitrogen Products Co. (*q.v.*). Finishing and sizing materials for textile and other trades and a line of pigment colors. In charge of exhibit: Adriaan Nagelvoort, Otto A. Fritz and H. D. Winship.

W. O. Arzinger Machinery Co.—A complete working model of the Simplex flotatien process on straight and selective flotation. In charge of exhibit: W. O. Arzinger.

Atlas Electric Devices Co.

Atlas Powder Co.—Special bottles of chemical products, high explosives, dynamite, blasting supplies and blasting powder. In charge of exhibit: E. E. Rese, E. L. B. Baptiste and H. V. Clark.

The Austin Co.—Photographs and descriptive matter of some of the chemical plants designed, constructed and equipped by this company. Working models of Austin standard buildings, together with actual sections of the materials entering into their construction. In charge of exhibit: C. F. Chard.

Bachmeier Co., Inc.—An exhibit of aniline dyes. In charge of exhibit: J. H. Bachmeier, G. M. Lord and E. J. Struck.

Bailey Meter Co.—Various types of Bailey fluid meters for measuring steam, water, gases and chemicals; V-notch Weir meter, 50,000 lb. per hour capacity, in operation; two fluid meters in operation, one with orifice in 4-in. water line, the other with orifice in 6-in. air line. In charge of exhibit: E. G. Bailey and W. E. East.

J. T. Baker Chemical Co.—A line of chemical reagents specifically known as "Baker's analyzed chemicals." In charge of exhibit: William P. Fitzgerald.

Bausch & Lomb Optical Co.

The Barrett Co.—Joint exhibit with National Aniline & Chemical Corporation, General Chemical Co., Semet-Solvay Co., and the Solvay Process Co. The Barrett Co. will contribute a chart showing (by means of samples) the interrelation of about 200 coal-tar products. A newly developed coal-tar resin, paracoumarone (trade name Cumar); Naphthalene; benzols, toluols; phenols, cresols, cresylic acids, etc., will also be shown. In charge of exhibit: H. S. Sidebottom, F. E. Dodge, R. O. Phillips, C. P. Brown, W. W. King, R. P. Dunning, W. B. Rogers and W. E. Lupe.

Beach-Russ Co.—Vacuum pumps, pressure blowers, oil pumps, acid pumps, gas boosters, pebble mills, rotary cutters and laboratory mills, featuring high-vacuum pumps guaranteed to exhaust to within $\frac{1}{6}$ in. of barometer. In charge of exhibit: C. A. Beach, H. C. Russ and W. S. Ransom.

Christian Becker, Inc.—Chainomatic balances, featuring specific gravity chainomatic balance, which has only recently been placed on the market. With this balance determinations are speedily made and readings are taken directly from the graduated scale, the Vernier reading to the fourth decimal place. Model No. 100 has a range of 0.400 to 2.000. In charge of exhibit: A. T. Millroy, D. Taylor, S. W. Hess and William L. Ferdon.

Beckley Perforating Co.—Perforated material of various descriptions and electrically welded tanks and specialties. In charge of exhibit: Otis Wright and Allen Price.

Beighlee Electric Co.—(See Cleveland Instrument Co.).

Benjamin Electric Mfg. Co.

Blackmer Rotary Pump Co.—A special unit for use in chemical plants consisting of a rotary pump mounted on cast iron sub-base and direct-connected to an electric motor, the complete unit being mounted on swivel casters, so that it can be moved from one part of the factory to another, in this way taking the place of several units. The pumps are provided with an automatic feature for taking up wear and removable linings, which can be changed in a few minutes. In charge of exhibit: J. H. Oldham and Arthur J. Schmitt.

Blair, Campbell & McLean, Inc.—A small size patent centrifugal gas and vapor scrubber so constructed that the inside mechanism can be readily inspected. In charge of exhibit: B. Dunglinson and A. C. Wood.

Bound Brook Chemical Co.

Boyer Oil Co.—Samples of the different oils and oil cake meals manufactured by the company. In charge of exhibit: Mr. Carper.

The Bristol Co.—Recording and indicating instruments for pressure, temperature and electricity. In charge of exhibit: H. G. Hall.

The Brown Instrument Co.—A complete line of high and low temperature measuring instruments, including indicating and recording thermometers and pyrometers for use in the chemical industry and for the control of high-temperature processes. Brown resistance thermometer for low temperature work. Indicating and recording pressure gages for air, vacuum, oil, water, draft, etc. Indicating and recording tachometers. In charge of exhibit: R. P. Brown, G. W. Keller, J. W. Lazear, F. C. Mahoney, R. E. Soules, S. W. Thal and Richard Guest.

Brown Portable Conveying Machinery Co.—Two of the latest designs: a portable belt conveyor for handling loose materials and a portable tiering machine, the "Handilift." This last machine has three speeds and the brake is quick-acting and foolproof. The belt conveyor will handle any form of loose material and has an ingenious scoop or shovel end which allows the material to be scraped on to the belt. In charge of exhibit: Harwood Frost and Elmer D. Bushnell.

Buffalo Foundry & Machine Co.—Chemical apparatus: Vacuum driers of various types, including a vacuum drum drier in operation; evaporators, featuring a special type rapid circulation evaporator; kettles, autoclaves, caustic pots, nitrators, etc. In charge of exhibit: E. G. Rippel and others.

Butterworth-Judson Corp.—Mill dyeings of chrome colors on men's wear and dress goods; also a complete set of raw stock dyeings. In charge of exhibit: W. H. Clark and Edward A. MacKinnon.

Canada Carbide Co.—Samples of carbide, showing the various sizes in which it is manufactured for domestic and foreign trade. In charge of exhibit: H. E. Mussett.

Canadian Electrode Co.—Special features will be a 17-in. round amorphous carbon electrode and a 16 by 16 in. square amorphous carbon electrode, each approximately 5½ ft. long. In charge of exhibit: H. E. Mussett.

Canadian Electro Products Co., Ltd.—Synthetic organic products derived from acetylene, including glacial acetic acid, paraldehyde, aldamine, acetaldehyde, acetic anhydride. In charge of exhibit: V. C. Bartram.

Canadian National Railways.

The Carborundum Co.—Carborundum refractories, including carbofrax and refrax brick, tile, muffles, tubes; carborundum refractory cement; carbofrax saggers, firesand; silicon metal; carborundum and aloxite wheels, paper and cloth. In charge of exhibit: Otis Hutchins, M. L. Hartmann, S. C. Linbarger and C. E. Hawke.

Carnotite Reduction Co.

Carrier Engineering Corp.—A complete operating installation of Carrier humidifying equipment, including the humidifier, fan and motor and automatic control instruments regulating the air delivery. The fan outlet will be provided with a diffuser so that the effects of the humidifier can be observed by noting the condition of the effluent air. In charge of exhibit: E. P. Heckel, H. B. Matzen and J. E. Bolling.

Celite Products Co.—Demonstrations and illustrations showing the use of Sil-O-Cel for heat insulation in various industries and also various applications of Filter-Cel, a material used for filtering various liquids. Typical uses of Celite, a light weight mineral filler, will also be illustrated. In charge of exhibit: P. A. Boeck, Thomas G. Lee, A. W. Knight and others.

Celluloid Zapon Co.—Unlimited color range of Zapon air drying enamels will be shown on merchandise as small as beads and as large as furniture. Silverware and highly polished metal will portray the value of Zapon air drying lacquer. Various types of products requiring a dipped or sprayed finish will also be shown. In charge of exhibit: Frank P. Davis, and representative from the New York office.

Central Scientific Co.—DeKhotinsky constant temperature drying ovens, incubators, water baths and thermostats. The Cenco-Nelson high vacuum pump, Cenco hydrogen ion determination apparatus, Cenco electric heater for gasoline distillation, duNouy surface tension apparatus, gas analysis apparatus of various types. In charge of exhibit: S. L. Redman, A. B. Carter, S. R. Evans, E. C. Leamon and others.

Challenge Co.—(See Tower and Wooden Tank Industrial Council).

Chemical Construction Co.—Detailed plans of acid plants. Materials used in acidproof masonry construction and a model acid tower built of acidproof brick and cement showing interior construction. In charge of exhibit: T. C. Oliver and R. L. Rutzler.

Chemical Equipment Co.

Chemical Foundation, Inc.

Chicago Pneumatic Tool Co.—Simplate valve air compressor, electrically operated; Boyer pneumatic hammers; pneumatic, riveting, chipping, calking and scaling hammers; Little Giant pneumatic and electric drills and grinders; "Hummer" and valveless type rock drills, etc. In charge of exhibit: W. P. Pressinger, H. L. Dean, T. J. Hudson, C. B. Coates and others.

Antoine Chiris Co.—A comprehensive line of essential oils and synthetic chemical products; exhibit of successive steps in the manufacture of selected products from the raw materials; Capes viscose as applied to various types of packages. In charge of exhibit: G. F. Richmond.

The Cleveland-Cliffs Iron Co.—Materials obtained from wood by the wood carbonization process, including methyl alcohol, acetone and acetic acid. In charge of exhibit: Charles B. Hall.

The Cleveland Instrument Co., successor to the Beighlee Electric Company, Inc.—Recording and indicating pyrometer equipment of both resistance and thermo-electric type, the latter using a patented compensating feature which takes care of variations in the cold junction of the thermocouples thus obviating the necessity of expensive lead wires and burying the cold junction. In charge of exhibit: W. H. Chappel.

Clinchfield Products Corp.

Contact Process Co.—Sulphuric acid, muriatic acid, mixed (nitrating) acid, nitric acid, salt cake, etc. In charge of exhibit: E. R. Henderson, Dr. von Rucker and Truman Smith.

Coors Chemical Porcelain Co.

Corning Glass Works—Glass laboratory apparatus made of pyrex glass. In charge of exhibit: G. Willis Drake, Irving B. Cary, F. F. Pfeiffer and F. Kraissl.

Crane Co.—A complete line of valves and fittings for handling of steam, air, gas and water in chemical plants; electrical temperature control valve for maintaining constant temperature; working exhibit of Cranetile traps for handling condensation under low and high pressure. In charge of exhibit: Edmund Burke, W. L. Goddard, F. E. McCreary, W. A. Dallach, R. M. Miller and W. F. Lambin.

Crane Packing Co.—"John Crane" flexible metallic packing in coil and ring form—a packing suitable for steam, air, ammonia, sulphuric acid, and which can be used in the form of gaskets on condensers and evaporators. In charge of exhibit: F. E. Payne, H. W. Lamb, K. M. Bickel.

A. Daigger & Co.—Standard chemical equipment with special chemicals and equipment developed to meet the recent necessities. In charge of exhibit: Charles Rascher and R. I. Wishnick.

The J. H. Day Co.—Special mixing machines for powders, paste and heavy masses; also grinding machinery. In charge of exhibit: C. F. Cone and F. M. Dudley.

The DeLaval Separator Co.—DeLaval oil purifier, varnish clarifier, yeast separator, blood albumen separator, centrifugal filter and gasoline purifier. With each machine there will be an exhibit of the materials handled by the machine showing the different stages from raw material to finished product. In charge of exhibit: H. C. Beckman, H. M. Beach, C. F. Meissner, A. Alexander and others.

The Denver Engineering Works Co.—Ruth counter current flotation machine and the Richards pulsator jig, with working models in operation. In charge of exhibit: Alfred Tellman and Joseph P. Ruth.

The Denver Fire Clay Co.—A full line of fire clay specialties; new large-size melting crucible; low-pressure fuel oil furnace, oil crushers, samplers, sieves, and a complete set of the Lind interchangeable electroscope. In charge of exhibit: L. W. Hoshour and George W. Lindsay.

Detroit Electric Furnace Co—A 500-lb. Detroit electric furnace for non-ferrous metals. In charge of exhibit: E. L. Crosby, A. E. Rhoads, H. M. St. John, M. G. Carhart and George B. Cross.

The Detroit Range Boiler & Steel Barrel Co.—A complete line of Detroit drums and Perfect metal bilge barrels, the latter being in two styles, a tight package for shipment of liquids of a volatile nature and a package with a removable head which is designed for shipment of solids or semi-solids. In charge of exhibit: E. W. Sanborn and A. L. Lindeblad.

J. P. Devine Co.—Chemical apparatus such as chemical kettles, autoclaves, carbonators, small vacuum drying chambers (which will serve to illustrate the features of the large vacuum driers), motor-driven vacuum pumps. The Kek Manufacturing Co., a subsidiary, will exhibit the Kek grinding and pulverizing mill in two sizes. In charge of exhibit: J. P. Devine, C. P. Devine and George Galloway.

Diamond State Fibre Co.—A general line of fiber sheets, rods and tubes, together with special parts such as gears, gaskets, combs, etc. Protective paper: greaseproof, vegetable parchment, parchmoid, glassine and filter paper. In charge of exhibit: Theodore Herkert and B. M. Lewis.

Dings Magnetic Separator Co.—Several types of magnetic separators; Type "M" No. 1 unit, magnetic pulley type separator, standard Wetherill high intensity unit. The two former are used for extracting strongly magnetic material from chemical products, and the Wetherill machine is applied very successfully to the concentration of minerals, chemicals, etc. In charge of exhibit: R. A. Manegold, E. S. Hirschberg and G. H. Fobian.

Dominion Water Power Branch.

The Dorr Co.—The Dorr tray thickener, the Dorrco pump and Dorr bowl classifier will be shown in closed circuit operation on a semi-commercial scale demonstrating their application in a typcial problem of separating and dewatering two products of different physical character. Samples of materials handled with or produced by Dorr equipment will also be shown. In charge of exhibit: H. N. Spicer, C. Lee Peck, F. F. Peters, P. M. McHugh, E. R. Ramsay and G. W. Repetti.

The Dow Chemical Co.—Samples of the 86 products manufactured by the company will be shown, duplicate samples being provided with loose stoppers for convenience in closer examination. Two new products will be shown, phenyl-ethyl-alcohol and di-phenyl-oxide. The oxychloride cement floor will be demonstrated in one corner of the booth and by means of an abrasive machine the wearing qualities of this type of flooring will be compared with those of the ordinary concrete floor. In charge of exhibit: D. A. Newland and R. K. Snow.

P. W. Drackett & Sons Co.

Draper Mfg. Co.

Drying Systems, Inc.

Dunck Tank Works. — (See Tower and Wooden Tank Industrial Council).

Duririon Castings Co.—Acidproof equipment, including pumps, fans, ejectors and pulsometers, improved type condensers, concentrators for sulphuric and other acids, mixing kettles, denitrator towers and a full line of standard Duriron pipe and fittings. In charge of exhibit: Pierce D. Schenck, Joseph Dart, Jr., R. F. Schmidt, G. A. Cocup, J. W. Swaren, E. A. Suverkrop and R. H. B. Elkins.

Eagle Tank Co.—(See Tower and Wooden Tank Industrial Council).

Eastman Kodak Co.—Research organic chemicals for university laboratories. In charge of exhibit: I. N. Hultman, Miss Anne W. Davis and Miss Ethel Schram.

Economic Machinery Co.

Economy Engineering Co.

Edgar Bros Co.

The Egyptian Lacquer Mfg. Co.—A comprehensive and varied line of finished articles showing application of lacquers, thinners, enamels and similar products. In charge of exhibit: G. W. Griffiths, Nathan P. Hunter Simeon Smith and G. J. Henry.

Eimer & Amend—A general line of laboratory apparatus with several new laboratory specialties as well as improved types of standard apparatus. In charge of exhibit: C. G. Amend, W. R. Eimer, T. M. Saulters, L. E. Fluger and F. C. Eibell.

The Electric Furnace Co. — Baily electric furnace of standard type melting copper together with specimens of the wide range of products that are being melted in American foundries in this furnace. In charge of exhibit: T. F. Baily, R. F. Benzinger and F. J. Peterson.

Electro Bleaching Gas Co.—Chlorine control apparatus, containers for transporting chlorine gas, and samples of textile fabrics bleached and finished by the use of liquid chlorine. **The Niagara Alkali Co.** will have an exhibit in the same booth consisting of small samples of various alkali products, including caustic soda and potash.

Electrolytic Engineering Co.

Electron Chemical Co.—A model size of the 12/1500 amp. Allen-Moore cell, together with the latest addition to the Allen-Moore cell family; namely, the 50-amp. size. In charge of exhibit: Mr. Kent, R. Fox and H. D. Marsh.

G. H. Elmore — Acidproof centrifugal pumps. These pumps are made of two distinct types for non-corrosive metallic alloys; the first recommended for use with acids such as acetic, formic, hydrofluoric, sulphuric, etc., and the second for nitric, hydrochloric, chromic and mixed acids, ammonium hydroxide, etc. In charge of exhibit: G. H. Elmore and A. C. Wood.

The Elyria Enameled Products Co.—Three new pieces of apparatus which have been developed recently: A 48-in. complete still, 250 gal. capacity; an 18-in. still, 10 gal. capacity, and a 100-gal. evaporating dish which is 60 in. in diameter and 24 in. deep. In charge of exhibit: J. E. Simpson, D. M. Webster, Fred B. Morris, W. E. Gray, E. P. Poste, R. F. Goerke and Max Donaver.

Charles Engelhard — Engelhard Le Chatelier pyrometers, platinum electric resistance thermometers, electric resistance type furnaces, transparent quartz glass, Impervite refractories and porcelains. In charge of exhibit: E. S. Newcomb.

Everlasting Valve Co.—Everlasting valve and Wilson cup valve. The effect of dilute sulphuric acid on various metals will be demonstrated in order to make a comparison with Aterite, a metal which is being used to make valves for certain acid work. In charge of exhibit: E. N. Corning and Ernest G. Jarvis.

Fansteel Products Co., Inc.

W. L. Fleisher & Co., Inc.—Model of air conditioning apparatus similar in design to that recently installed in several large plants. Model of driers for mineral, vegetable and animal products, together with samples of products dried in these machines. Models of typical power plant installations, direct and blast heating systems, ventilating layouts, and general layouts for industrial plants. In charge of exhibit: W. L. Fleisher, A. W. Dissauer and R. E. Keyes.

Foamite Firefoam Co.—A model of an oil refinery showing the efficiency of this method of extinguishing oil fires; a 40-gal. model "F" engine; 5-gal. steel extinguishers; 3-gal. approved Foamite fire pails; 2½-gal. approved copper Foamite firefoam extinguishers and recharges. In charge of exhibit: G. B. James and A. E. Canaday.

Foote Mineral Co.—Display of unusual ores, rare elements and ferro-alloys, together with manufactured articles into which they enter. A complete line of zirconia products with electric furnace to demonstrate the super-refractory qualities of Zirkite and Zirkonalba. In charge of exhibit: W. M. Foote, H. C. Meyer and W. A. Koenig.

The Forests Products Laboratory, U. S. Department of Agriculture—Testing, preparation and application of various glues, particularly those used in aircraft manufacture.

The Foxboro Co., Inc.—A new liquid level recorder with a special water seal, making it possible to use this instrument on oils and other liquids lighter than water which would naturally attack a rubber diaphragm. A new Foxboro-Heath CO$_2$ recorder and an automatic temperature controller will be in operation. In charge of exhibit: A. F. Mundy, F. W. Carret, Mr. Neely and Mr. Roessner.

Fuel Products Co.

Fuller-Lehigh Co.

William Gaertner & Co — Instruments of precision: Cathetometer, comparator, spectroscope, spectrometer, gas and fuel calorimeters. Universal laboratory supports, laboratory telescopes and microscopes. In charge of exhibit: William Gaertner and C. D. Miller.

Wm. Garrigue & Co.

Chas. F. Garrigues Co. — Various grades of potash from first sorts to persulphate, caustic potash sticks of the U. S. P. pure white and alcohol purified grades; caustic soda sticks; benzoate of soda and benzoic acid, U. S. P. white odorless and tasteless; stearates of zinc and aluminum, etc. In charge of exhibit: H. D. Wellman, Mr. Campbell and Mr. Anderson.

Gary Chemical Co., Inc.—Ortho- and para-nitrotoluol. Ortho- and para-toluidine. In charge of exhibit: V. U. Young and Roger N. Holcomb.

General American Tank Car Corporation — Photographs and drawings of tank cars. In charge of exhibit: Hugh Epstein, Ralph Epstein and Joseph Epstein.

General Bakelite Co.—A full line of Bakelite applications, including Bakelite varnish, lacquer, enamel, cement, transparent and colored material, molded parts, sheets, rods and tubes. A small Bakelite molding press will be in operation to show the fabrication of the material from the raw state to the finished article. In charge of exhibit: Hylton Swan, Herbert S. May, William S. Gordon, Jr., and L. M. Rossi.

General Ceramics Co.—Small models (averaging about 10 in. in height) of practically all of the acidproof stoneware containers, machines, etc., manufactured by this company. These models are exact reproductions of standard apparatus so that visitors will have an opportunity to inspect a complete line of acidproof stoneware. In charge of exhibit: Percy C. Kingsbury.

General Chemical Co.—Standard acids and chemicals, also Ryzon baking powder and Orchard Brand insecticides and fungicides. A number of products manufactured by customers of the company will be shown, such as tin plate, glues, dyes, explosives, fertilizers, artificial leather, celluloid, pharmaceuticals, etc. In charge of exhibits: N. Peterkin and George P. Adamson.

General Electric Co.—A model of the Cottrell precipitation outfit used by the Gellert Engineering Co. for recovering potash from blast-furnace gases will be shown in operation. A KT-312-6-15-hp., 1200-r.p.m., 440-v. motor with frame and coils completely coated with an acid-resisting insulation, which is particularly adapted for use in chemical and fertilizer plants. A RC-24, 2-hp., 1150-r.p.m., 230-v. totally enclosed DS-2 shunt wound motor equipped with new Arguto plug bearings. In charge of exhibit: Chester T. McLoughlin, Raymond Barclay and other representatives.

General Filtration Co., Inc.—Acidproof Filtros filter plates in various sizes, shapes and grades; electrofiltros acidproof diaphragms for electrolytic work; acidproof cement. In charge of exhibit: F. E. Leiby and W. W. Robacher.

General Fire Extinguisher Co. — The Grinnell automatic sprinkler will be installed in a large wire-glass house in which a fire will be started once every hour to show the automatic action of the sprinkler system in extinguishing a fire. The working principle of the sprinkler head will be demonstrated by a large working model 3 ft. high. In charge of exhibit: Frank V. Sackett, Howard E. Branch, Theodore Fertig, John G. Thomas, A. E. Gauslin, H. D. MacDonald, H. H. Duley, H. O. Booth, S. Dorais and J. F. Gilmore.

Glamorgan Pipe & Foundry Co—Models of continuous gas-fired limekiln and causticizing tower. Improved rotary continuous suction filter in operation. Caustic flaker in operation. In charge of exhibit: W. D. Mount and C. H. Himnant.

Glens Falls Machine Works—Pulp and paper machinery, including Glens Falls rotary sulphur burner, Woods thickener machine for guncotton and chemical pulp, and the new split-cam for quick repair work on screens. In charge of exhibit: James H. Haines and others.

Gordon Dryer Corp.—"AA" size Gordon high-efficiency atmospheric drier. This size has grown very popular among colleges and research laboratories, as it is an ideal type of unit for small batch production. There will also be on exhibition a "D" drier, this unit containing 500 sq.ft. of effective drying surface. Both outfits will be complete so that drying tests can be made for any interested customer. In charge of exhibit: Nathan Owitz, R. R. James, H. D. Harvey and Richard B. Hewitt.

Goulds Mfg. Co.

Groch Centrifugal Flotation, Ltd.—A new model flotation machine in which the impeller acts as a centrifugal pumps, sucking air and oil through a hollow shaft. On striking the impeller blades the oil is broken up into small bubbles and thoroughly mixed with the solution, giving ideal flotation conditions. In charge of exhibit: Frank Groch, N. C. Groch and T. Garster.

Gruendler Patent Crusher & Pulverizer Co.

The Guernsey Earthenware Co.—Chemical laboratory porcelain: Crucibles, filter plates, casseroles, combustion capsules, evaporating dishes, beakers, concentric rings, filter rings, dye pots, funnels, desiccator plates, combustion tubes, porous cells, etc. In charge of exhibit: Allan L. Goulding.

Hamilton & Hansell, Inc.—A 500-lb. Rennerfelt furnace of the type which has been widely used in steel making and in the melting of ferrous and non-ferrous alloys. In charge of exhibit: H. A. DeFries and Thomas Hagelthorn.

Hanovia Chemical & Manufacturing Co.—Laboratory apparatus of pure transparent quartz glass featuring very fine quartz fibers for instrument suspension and special vacuum discharge tubes for rare gases. Platinum wound electric laboratory furnaces. Direct reading electric resistance thermometers for central station industrial temperature control. Quartz mercury vapor lamps for research work with ultra-violet rays. In charge of exhibit: E. W. Fisher.

Hardinge Conical Mill Co.—An exact model of the Hardinge conical ball mill will be in operation. Large users of the Hardinge mill will be featured by name and photographs of their installations will be shown. In charge of exhibit: Captain Harlowe Hardinge.

Hauser-Stander Tank Co.—See Tower and Wooden Tank Industrial Council).

Haynes Stellite Co.

Frank Hemingway, Inc.

S. S. Hepworth Co.—Centrifugals of all types in operation including a large electrically driven two-speed centrifugal capable of handling five tons of material per hour; water-driven centrifugal; Macintosh ball-bearing centrifugal and an under-driven machine, suitable for products in small quantities or where there are fumes requiring the top to be sealed. Hand-operated and power-driven unloaders. In charge of exhibit: Bruno C. Lechler, C. A. Olcott and E. F. Babbitt.

Hercules Engineering Corp.—A nitrator and an autoclave, having certain distinctive features which should be of interest to operators whose work requires equipment of this sort. Interesting information on Hercules evaporators, concentrators and equipment for the generation, compression and liquefaction of gases. In charge of exhibit: R. D. Kehoe, A. R. Calvo, W. H. Campbell, T. J. Brewster and Richard Neuhaus.

Hercules Power Co.—A complete line of organic chemicals including organic acids, valerates, pyroxylin solutions, waterproof cements, soluble cotton and solvents. The special features will be sodium alginate (Algin No. 3), which is being used as a sizing material for split leather, leather cloth and other fabrics. In charge of exhibit: G. C. O'Brien and W. L. Holter.

Herold China & Pottery Co.

J. D. Hollingshead Co.

Hood, B. Mifflin, Brick Co.

Hooker Electrochemical Co.

Hoskins Manufacturing Co.—Laboratory electric furnaces, hot plates and thermo-electric pyrometers of the indicating and recording types, featuring a new multiple recording pyrometer, which will be in operation. In charge of exhibit: C. F. Busse, W. D. Little and C. S. Kinnison.

Huff Electrostatic Separator Co.—A half-size electrostatic separator operating with samples of various minerals, showing separation of copper and tin from tungsten, ilmenite from sand, rutile from zircon, lead from barytes, etc. Plumb pneumatic jig, laboratory size, which is a dry process and for that reason is particularly adapted to the concentration of ores where water is scarce. In charge of exhibit: H. B. Johnson, F. R. Johnson, C. D. Burrage, Jr., and William E. McKee.

The Hunter Dry Kiln Co.—Models of automatically controlled humidity driers as well as samples of various materials dried by this system. In charge of exhibit: Harry Hunter, O. M. Ragsdale and Arthur B. Stonex.

Hyco Fuel Products Corp.

Ideal Stencil Machine Co.—Stencil machines for cutting paper stencils for marking shipments, stencil filing cabinets, stencil ink and other shipping-room supplies and equipment. In charge of exhibit: G. E. Berglund and J. W. Marsh.

Industrial Electric Furnace Co.

Industrial Filtration Corporation—Open tank type of filter, rotary hopper dewaterer and the continuous rotary filter. In charge of exhibit: G. D. Dickey and H. B. Faber.

Innis, Speiden & Co.

Irving Iron Works Co.—A platform consisting of different sizes of Irving-Subway recticuline grating, with stairways showing Irving safety steps. In charge of exhibit: W. E. Irving, P. L. Price and F. N. Dodge.

Jewell Polar Co.—Steam operated still together with storage tank in operation. Steam, gas and electric laboratory stills. In charge of exhibit: A. C. Jewell, R. E. Henry, J. E. Bloeser and George Hild.

Johnson & Carlson—(See Tower and Wooden Tank Industrial Council.)

Kek Mfg. Co.—(See J. P. Devine Co.)

Kenart Synthetic Products Co.—Numerous synthetic perfume and flavor bases, among them several not previously manufactured in this country; several pharmaceutical products; synthetic and vegetable food colors and dyes. In charge of exhibit: S. Wilmer Kendall and Hugh S. Stewart.

Kewaunee Mfg. Co.—Laboratory fixtures: Chemical case (919); fume hood (933); chemistry desks (895 and 939); dark-room desk (1424); peg board (1434); exhibit case (1460); combustion table (909). In charge of exhibit: F. H. Wiese, R. A. Hanna, William E. Mix, O. T. Louis, F. M. Hassett and R. G. Siple.

Maurice A. Knight—A full carload of large standard and special pieces of chemical stoneware apparatus, as well as several complicated and small pieces. In charge of exhibit: Maurice A. Knight, Charles Dennison, Percy Sawyer and Samuel J. Baril.

The Koppers Co.—One of the features will be a display of coke and by-products in the proportions produced in the coking of Illinois coal in Koppers ovens, based on official records of the U. S. Bureau of Standards. A new type of by-product coke oven exhibited for the first time. Model of the Koppers by-product coke oven. In charge of exhibit: E. L. Crowe and E. H. Bird.

Lammert & Mann Co.—Several sizes and styles of rotary dry vacuum pumps, some of which will be in operation. In charge of exhibit: Donald Rosie, Lawrence Eisenbies and R. F. Lammert.

Lead Lined Iron Pipe Co.

Leeds & Northrup Co.—Different forms of apparatus—some of which will be shown in operation—for electrically determining the acidity or alkalinity of solutions. Equipments for electrolytic conductivity measurements, and an automatic recorder, which can be applied to recording changes in any process in which such changes are accompanied by changes in electrolytic resistance. Hand-operated and automatic recording potentiometers for temperature measurements of various ranges; a White combination potentiometer for precision thermocouple measurements; an optical pyrometer for accurate determinations of high temperatures, above the range of thermocouples; and other forms of apparatus of interest to chemists. In charge of exhibit: Paul E. Klopsteg, I. Melville Stein, G. W. Tall, Jr., H. Brewer and O. Brewer.

Lindsay Light Co.

The Liquid Carbonic Co.—A working exhibit demonstrating the methods and apparatus used to adapt CO_2 to such pressures and temperatures as are required for its use in commercial processes. Complete outfits for large and small users, pressure regulators and tempering coils for CO_2, oxygen, acetylene and other gases. In charge of booth: J. H. Pratt, E. D. Hale, W. S. Hopkins and R. D. Crisp.

Arthur D. Little, Inc.—Pictures of the firm's building and laboratories, with pamphlets describing the facilities for solving problems of applied chemistry. In charge of exhibit: H. L. Sherman and Clarence J. West.

Lungmotor Co.

Emil E. Lungwitz—A Kelly filter press, type 150, made of steel and iron, and a type 30 press, made of copper throughout. In charge of exhibit: Emil E. Lungwitz, H. L. Dick and Wm. D. Neuberg.

The Lunkerheimer Co.

Macbeth-Evans Glass Co.—Representative samples of laboratory glassware. In charge of exhibit: F. K. Pinckney and J. F. Humez.

Machinery Utilities Co

Magnetic Manufacturing Co.—Magnetic pulley separator for separating iron from various sorts of materials. Type "L", No. 4, magnetic separator for separating iron from brass, aluminum and bronze turnings and other fine material. High intensity laboratory type for separating feebly magnetic materials such as ores, abrasive materials, etc. In charge of exhibit: J. P. Bethke.

Mann & Cook.

Marden, Orth & Hastings Corporation—Dyes and intermediates manufactured by the Calco Chemical Co. Processed fish oils for the paint and varnish industries. Tanning oils, moellons and extracts. Samples of results obtained by using these various products. In charge of exhibit: Mr. Breuer and Mr. Johnston.

Marietta Refining Co.—Malachite green; from raw products to finished crystals, some of these weighing 42 lb. each. About 150 different articles dyed or colored with malachite green. In charge of exhibit: H. C. Phelan.

The Mathieson Alkali Works, Inc.—Caustic soda, soda ash, liquid chlorine, bleaching powder and other Eagle-Thistle brand heavy chemicals. Solvents, including tetrachlorethane, ethylene chloride and similar products. In charge of exhibit: Adriaan Nagelvoort, Otto A. Fritz and H. D. Winship.

Mead & Co.—Mead mills. In charge of exhibit: Paul O. Abbe and staff of Paul O. Abbe, Inc.

Merck & Co.—Emphasis will be placed on the exhibit of medicinal chemicals, particularly those developed since the outbreak of the war, such as bismuth salts, iodine and iodides, salicylates, salol, synthetic oil of wintergreen, etc. Chemical reagents of a high standard of purity.

The Merrill Co.—The Nordstrom lubricated plug valve, which is so constructed that, in case the valve sticks, the plug can be lifted from the seat, insuring proper lubrication of the bearing surfaces. In charge of exhibit: C. C. Broadwater, L. D. Mills and S. J. Nordstrom.

Metals Disintegrating Co., Inc.—Lead powder for carbon brushes and storage batteries. Tin powder for coated papers and carbon brush industry. Bronze powders for decorative purposes. Aluminum powder for fire works and calorizing. Copper powders for dye works and sherardizing. In charge of exhibit: S. G. Schatzberg.

Miner, Edgar Co.

Midwest Engine Co.

Mine Safety Appliances Co.

Mojonnier Bros. Co.—Mojonnier laboratory specialties: moisture testers, vacuum pumps, viscosimeters, extraction flasks and other laboratory glassware and accessories. In charge of exhibit: T. Mojonnier, J. J. Mojonnier, R. Moon, P. C. Mojonnier and F. D. Courtenay.

Monsanto Chemical Works

J. L. Mott Iron Works—Apparatus with acid-resisting enamel such as laboratory antoclaves (one to 5 gal.), crystallizing pans and a complete distilling unit with vacuum still, condenser and container. In charge of exhibit: J. J. Blackmore and R. J. Shively.

Nash Engineering Co.—Nash Hytor air and gas compressors, Nash Hytor vacuum pumps, and Jennings Hytor vacuum heating pumps, assembled and in actual operation and apart for inspection. In charge of exhibit: Irving C. Jennings, Howard M. Wylie, and G. B. Wright.

Nassau Valve & Pump Corp.—"Chemetal" acid-resisting valves and horizontal centrifugal pumps. In charge of exhibit: E. J. Walsh, Henry A. Born, H. M. Pier and A. T. Haviland.

National Aniline & Chemical Co.

National Filter Cloth & Weaving Co.—Cotton filter cloth, which is specially constructed for filtering purposes, hence more advantageous to use than ordinary duck. In charge of exhibit: M. W. Smith and Edward Boffin.

Newark Wire Cloth Co.—A full line of wire cloth, sieves, filter cloths, etc. A high-power microscope will show the construction of patented filter cloth. In charge of exhibit: Alvin Allen Campbell.

New Jersey Zinc Co—Zinc oxides as used in high-grade paints. Slab zinc (spelter) in various grades, including the well-known "Horse Head" brand. Rolled zinc, lithopone, zinc chloride, sulphuric acid, muriatic acid, salt cake, spiegeleisen and zinc dust. In charge of exhibit: F. C. Ryan.

Newport Chemical Works, Inc.—The various steps in the manufacture of dyes from "coal to dyestuff" will be shown. In charge of exhibit: John W. Kopf and Giles Low.

Niagara Alkali Co.—(See Electro Bleaching Gas Co.).

Niagara Electro Chemical Co.

Nitrogen Products Co.—Sodium cyanide and other chemicals made by their synthetic process. In charge of exhibit: Adriaan Nagelvoort, H. D. Winship and Otto A. Fritz.

The Northwestern Chemical Co.—Synthetic flavors; butyrates, butyl acetate, amyl formate, caproic acid, valeric acid and valerates. In charge of exhibit: Robert L. Wilson and Miss H. M. Allen.

The Norton Co.—Alundum and crystolon refractories, laboratory ware and refractory cement, electrically sintered magnesia. Samples of ignition capsules, combustion boats, filtering cones, electric furnace cores, extraction thimbles, pyrometer tubes, and alundum and crystolon for electric furnaces. In charge of exhibit: H. R. Savage.

The S. Obermayer Co.

Ohio Pottery Co.

The Oliver Continuous Filter Co.—A 3-ft. diameter by 2-ft. face Oliver continuous filter in operation, showing distinctive features of this machine. Drum filters, a continuous and automatic Oliver horizontal filter used in products too coarse and fast settling to be handled on the drum filter. In charge of exhibit: R. G. Walker, H. A. Morrison, Paul R. Sheffer and W. Bohlman.

Ontario Bureau of Mines—Representative samples of ores and minerals from the various mineral areas in the Province, including Cobalt silver camp, Porcupine, Kirkland Lake and Boston Creek gold areas, Sudbury nickel region, etc. Feldspar, fluorspar, graphite, talc and molybdenite from eastern Ontario. Salt and salt products of the Canadian Salt Co. and soda ash from Brunner Mond Canada, Ltd., will be displayed. In charge of exhibit: W. K. McNeill and W. R. Rogers.

Organic Salt & Acid Co.—Thirty Orsac products, including salicylic acid and its salts and derivatives, ortho, meta and para cresotinic acids, triphenyl phosphate, tricresyl phosphate, benzyl alcohol, benzyl benzoate and benzyl acetate. In charge of exhibit: Karl Kolbe.

Palo Co.—Meker burners and furnaces as manufactured by G. Meker & Cie., Paris; Link automatic water still; Hess-Ives tint photometer, the only instrument that will determine color values of liquids and solids by a numerical expression without involving the personal equation; Durieux filter paper; Palo absorber; Lane Laboratory burners, etc. In charge of exhibit: M. J. Seavy.

Parks-Cramer Co.—Parks-Cramer hot oil circulating systems. One 200,000-B.t.u. Merrill process system consisting of absorber setting and coil, motor-driven oil-circulating positive pressure rotary pump, thermostatic control apparatus and all necessary accessories. The system will be connected to a Dopp kettle. Guyton & Comfer jacketed pipe fittings. In charge of exhibit: A. W. Thompson, A. B. McKechnie and C. A. Willard.

Pennsylvania Salt Manufacturing Co.—Heavy chemicals in large glass containers.

The Permutit Co.—A small Zeolite water softener for demonstration purposes, and photographs showing installations of various types of water-rectifying apparatus. A complete list of Permutit apparatus displayed on cards and literature describing the apparatus. In charge of exhibit: Albert Tate Smith, Benjamin M. Ferguson, Frank S. Dunham, Class Kennicott, C. A. Roberts and H. G. Taylor.

Perth Amboy Chemical Works.

Leonard Peterson & Co., Inc.—High-grade laboratory furniture to exhibit laboratory glassware and apparatus manufactured by E. H. Sargent & Co. In charge of exhibit: Leonard Peterson, O. L. Lethander and Bernard Wiest.

The Pfaudler Co.—A 26-gal. utility pot with accessory apparatus; a 6-gal. Milwaukee pot; a 32-gal, Milwaukee pot; a 50-gal. open jacketed tank; a 141-gal. open jacketed evaporating pan; a 500-gal. closed jacketed tank with enameled agitator; a 500-gal. closed tank. All this apparatus lined with Pfaudler acid-resistant glass enamel. In charge of exhibit: R. B. Kilmer, O. I. Chormann, W. E. Foster and H. R. Allen.

The Philadelphia Drying Machinery Co.—Several working models of "Hurricane" driers for chemicals, clay and porcelain. Also collection of photographs showing installations in representative plants throughout the United States. In charge of exhibit: Walter W. Sibson, C. H. Reumann and H. C. Moore.

Philadelphia Quartz Co.—Various grades of manufactured silicate of soda, with literature on the principal uses of each grade as applied. In charge of exhibit: C. F. Wolcott, G. W. Wait and E. A. Russell.

The Philadelphia Textile Machinery Co.—A model of a Proctor four-truck drier for paints, chemicals, colors, etc. A model of Proctor three-conveyor drier for cotton, wool, chemicals, etc. A large display of all kinds of materials dried in Proctor Research Laboratory. In charge of exhibit: E. B. Ayres, Mrs. J. C. Reiter, W. R. Murray, Joseph Tiers and W. J. Dudley.

Pneumercator Co., Inc.—A working outfit illustrating the simplicity of operation of the pneumercator tank gage. Various models will be shown. In charge of exhibit: William Thomas, A. F. Kuehne and Henry Jones.

Pratt Engineering & Machine Co.—Photographs of machinery and apparatus manufactured for the chemical and fertilizer trade, and photographs of various plants designed and erected by this company for the manufacture of sulphuric and nitric acids and fertilizers. Designs of plants for the manufacture of acid phosphate and commercial fertilizers and sulphuric acid. In charge of exhibit: George F. Hurt, G. A. Austen, E. E. Maher and C. A. Murphey.

Precision Instrument Co.—Carbon dioxide, sulphur dioxide, recorders, indicating draft gages (single, 2 in 1, to 5 in 1), recording gages, calorgraph, gravitometer, coal calorimeter, and other apparatus for testing and measuring gases. The precision CO_2 recorder delivers every 3 min. a definite fixed volume of flue gas, analyzes the mixture and then records on a chart the percentage of carbon dioxide present. It is accurate to within 0.5 per cent. In charge of exhibit: Charles E. Conway.

Precision Thermometer & Instrument Co.

Pressed Steel Tank Co.

Product Sales Co.

Provost Engineering Corp.

Pyrolectric Instrument Co.—Electrical precision instruments, a-c and d-c galvanometers, electrometers, etc. A new type of lamp and scale reflection indicator, the Northrup pyrovolter, a small Northrup-Ajax high-frequency induction furnace with water-cooled induction coil, in operation. In charge of exhibit: H. F. Porter and W. C. Harter.

Quigley Furnace Specialties Co.—Temperature tests on the bonding strength of Hytempite, a highly refractory plastic material for bonding fire brick, etc. Carbosand, a highly refractory fire sand for making rammed-in linings. Insulbrix, a specially prepared cellular insulating brick for furnaces; Quigley powdered coal system for preparing, transporting and burning powdered coal. In charge of exhibit: W. S. Quigley, H. A. Kimber, W. O. Renkin, J. G. Coutant and L. G. McPhee.

Raritan Copper Works and the Anaconda Copper Mining Co.—By-products obtained during the electrolytic refining of copper: White arsenic, tellurium oxide, tellurium, selenium, gold, silver, platinum and palladium, nickel and copper sulphates. Lead from the International Lead Refining Co., East Chicago, Ind., high-grade electrolytic zinc from the Great Falls Refinery, "Anaconda white lead" from the Anaconda Lead Products Co., East Chicago, Ind., products of the new copper rolling mill. In charge of exhibit: S. Skowronski and H. D. Hawks.

Raymond Bros. Impact Pulverizer Co.—Four models in operation illustrating the various types of pulverizing mills manufactured by this company, three to be one-quarter size of the actual machines and one full-size model small No. 0000 pulverizer used extensively in the chemical, dry color and dyestuff industries. In charge of exhibit: C. M. Lauritzen, W. M. Cook, S. B. Kanowitz, R. A. Lachmann and W. B. Senseman.

Redmanol Chemical Products Co.—Cigar and cigarette holders manufactured from transparent redmanol. Demonstration of manufacture of molded parts from redmanol molding mixtures. In charge of exhibit: L. V. Redman.

Republic Flow Meters Co.—The regular Republic flow meter, together with a recently developed flow meter for making very low differential pressures. This meter measures accurately as low as one-thousandth of an inch water differential pressure. A blower will be installed in the booth so that both meters will be operating under regular conditions. In charge of exhibit: James D. Cunningham, J. M. Spitzglass, C. R. Matheny, C. E. McGregor, J. Tigerman and T. S. Williams.

Research Corporation.

Research Laboratory of Chicago.

Revolvator Co—Models of revolving portable elevators. In charge of exhibit: H. S. Germond, Jr., and others.

Roessler & Hasslacher Chem. Co.

Rollin Chemical Co.

Rossendale-Reddaway Belting & Hose Co.

Sarco Co., Inc.—A complete line of thermostatic steam and radiator traps, metallic gaskets and several models of standard and special temperature regulators. In charge of exhibit: Clement Wells, E. J. Ritchie, F. D. Harger, G. M. Cameron, G. F. Cordner and G. B. Burke.

E. H. Sargent Co.—Laboratory supplies.

Schaar & Co.—Chemical laboratory apparatus of American manufacture, including analytical balances, electric flask heaters, etc., manufactured by this company. American-made glassware, porcelain ware and apparatus handled for other manufacturers. In charge of exhibit: Adolph E. Schaar, Eric W. Ohman, Andrew R. Stevenson and J. Gardner Goodwin.

Schaeffer & Budenberg—Pressure and vacuum gages, mercurial pressure and vacuum gages, gage testers, "Crescent" industrial thermometers, "Reform" mercury thermometers, "Columbia" mercury recording thermometers and other testing apparatus. In charge of exhibit: C. E. George, and Messrs. Parker, Coesfeld and Campbell.

Joseph Schneible

Schutte & Koerting Co.—Equipment for handling chemiccal gases: automatic blowcase attachment, jet pumps, etc., used in handling of chemical liquids. Power-plant valves, spray nozzles, oil-burning equipment. In charge of exhibit: Dr. C. H. Kimberly, A. C. Nell and J. S. Patten.

Schwartz Section System—A sectional cabinet for filing laboratory chemicals and reagents, samples and specimens. In charge of exhibit: M. P. Schwartz.

Scientific Equipment Co.—(See Central Scientific Co. and Kawaunee Mfg. Co.)

Scientific Materials Co.—Standard lines of laboratory glassware and porcelain. Complete line of filter papers. Special graduated and blown glassware. The new Fisher burner; museum jars; Scimatco tubing, etc. In charge of exhibit: R. H. Hix and Dr. F. L. Hinckley.

Ernest Scott & Co.—Photographs showing installations made in the following industries: Oil extraction from nuts, seeds, beans, etc., by Scott's solvent process; extraction of grease from bones, packers' tankage, etc.; recovery of glycerine in soap factories and caustic soda from paper pulp spent liquors, cotton mercerizing mills, etc., by the Scott evaporator. Extraction of oil from fish and fish waste, glycol and glycerine refining plants, fatty acid distillation. In charge of exhibit: H. Austin, Robert MacGregor and C. E. Bradley.

Semet Solvay Co.

The Sharpless Specialty Co.—Various models of supercentrifugals featuring centrifugal equipment designed for use in the separation of paraffine wax from mineral oils, together with samples of resulting oils of different crudes. In charge of exhibit: Max B. Miller, F. A. Frank, E. E. Ayres and Walter E. Cox.

Shawinigan Electro Metals Co.

Shawinigan Water & Power Co.

Sherwin-Williams Co.

B. B. Shippers Supply Co.

The W. W. Sly Manufacturing Co.—A working installation of a "Sly" dust arrester for the collection and reclamation of dust. In charge of exhibit: P. W. Graue and E. J. Moore.

Walter Soderling, Inc.

Solvay Process Co.

Sowers Manufacturing Co.—The construction of Dopp seamless steam jacketed kettles demonstrated by a sawed-up section of a 16-gal. kettle, showing that kettle wall, jacket and staybolts are one single casting with no joints, bolts, seams or welds. A 10-gal. Dopp standard vacuum pan with sweep mixer, 150-gal. Dopp standard kettle with ribbon-type mixer and 350-gal. Dopp rectangular kettle, 8 ft. x 3 ft. 6 in. x 2 ft. deep. In charge of exhibit: R. C. Boggess and P. B. Coxe.

D. R. Sperry & Co—Filter presses, plates and frames made of various materials, filter press cocks and various plate surfaces. In charge of exhibit: D. R. Sperry and B. H. Conley.

The Star Brass Works—General line of spray nozzles in operation. In charge of exhibit: H. D. Binks, B. R. Sausen and C. R. Kranz.

Stein Hall & Co.

Stimpson Equipment Co.

C. H. Stoelting.

F. J. Stokes Machine Co.—Rotary tablet machine in operation making naphthalene balls. Powder-filling machine in operation. Rotary vacuum drier, laboratory vacuum drier, vertical surface condenser, copper vacuum still, automatic water still. In charge of exhibit: L. H. Bailey and C. F. Coleman.

Stresen-Reuter & Hancock, Inc.

Sturtevant Mill Co.—The "Open-Door" line of crushing, grinding, pulverizing, screening, mixing, elevating and conveying machinery. The "Open Door" will be especially featured as a labor and time saver. They swing like the door of a safe and open the interior of their various machines to more complete accessibility than can any number of parts or castings and plates, the removal of which costs so much in time wasted. In charge of exhibit: H. A. Tomlinson, L. N. Doyle, J. S. Vrabek and W. T. Doyle.

Sullivan Machinery Co.—A model air-lift pumping plant in operation, consisting of Sullivan air-lift pump, separating head, cyclone boosters, etc., electrically operated by compressed air; also samples of its acid pumps, separating heads in standard and special acid and chemical resistant material, and display photographs of installations and equipment. In charge of exhibit: John Oliphant, Howard T. Walsh, Joseph H. Brown, R. E. C. Martin and S. B. King.

Sunbeam Chemical Co.—Methylene blue, paranitrosodimethylaniline, and acid azo red, eosine, erythrosine, crude glycerine, sulphonated oils, and the dye soap "Rit." In charge of exhibit: L. C. Cates.

Swedish Crucible Steel Co.—Steel castings for heat-treating processes and for resisting oxidation under high temperature. Complimentary tickets to the Exhibition of the American Steel Treaters' Society will be issued at this booth. In charge of exhibit: H. H. Harris, Mr. Van Arman and Mr. Kingsley.

Swenson Evaporator Co.—One evaporator will be in operation, and another so arranged that an examination of the internal construction can be readily made. In charge of exhibit: F. M. deBeers, P. B. Sadtler, P. H. Appell, D. C. Giles, S. W. Hind, A. H. Boehmer and F. F. Mackentepe.

C. J. Tagliabue Mfg. Co.—"Tag" P. & W. liquid level and condensate controllers for automatically maintaining liquid levels in evaporators, closed and open tanks, etc. "Tag" self-operating and perfect automatic temperature and pressure controllers for automatically maintaining a uniform temperature or pressure regardless of a variable initial supply in coolers, driers, mixing kettles, stills, etc. "Tag" automatic combination time and temperature controller, the "Tag" absolute pressure controller. In charge of exhibit: Wallace W. White, D. M. Morgan and V. Wichum.

Tank Equipment Co.

Taylor Instrument Co.—Indicating and recording thermometers and pyrometers; laboratory and oil-testing instruments; pressure and temperature regulators. In charge of exhibit: Messrs. Ely, Amdursky, Schwartz, Taylor, Heyss, Pagenstecker, Lemke, Rinder, Levy, Sutherland, Drs. Clark and Hurlbert.

Technical Products Co.

Texas Gulf Sulphur Co.—In charge of exhibit: J. A. B. Landell and Arthur S. Cosler.

The Thermal Syndicate, Ltd.—Vitreosil products for laboratory and plant. Vitreosil is unaffected by the usual mineral acids or by sudden and extreme changes of temperature, as will be demonstrated by heating vitreosil crucibles to a temperature of approximately 1000 deg. C. and plunging them immediately into cold water. In charge of exhibit: Stephen L. Tyler and William W. Winship.

The Thermo Electric Instrument Co. — Freas and Thelco types of constant temperature apparatus, forced air and vacuum ovens, also the latest type, the Swirl oven, in which the operator can keep his material in constant agitation while it is subjected to a constant temperature. In charge of exhibit: E. H. Heacock, J. S. LaMer and Royal B. Freas.

Arthur H. Thomas Co.—Kelley electrometric titration apparatus for the determination of Cr, V, and Mn in steel and ferrous alloys. Cain electrometric titration apparatus for the determination of carbon in steel by the direct combustion method. Edwards gas density balance. Volumetric apparatus; electric drying ovens; Mandler diatomaceous filters, etc. In charge of exhibit: R. M. Miller, H. C. Roak and C. C. Roberts.

Thwing Instrument Co.—Recording and indicating pyrometers for all ranges of temperature, paper testing apparatus, particularly basis weight scales, and an instrument for recording the tearing strength of paper. In charge of exhibit: Dr. Charles B. Thwing and William S. Miller.

Titanium Alloy Mfg. Co.

Tolhurst Machine Works—A 32-in. heavy type suspended centrifugal with bottom discharge. Motor-driven 40-in. self-balancing centrifugal. A 20-in. solid curve centrifugal and a new type 12-in. laboratory centrifugal. In charge of exhibit: John S. Gage, T. A. Bryson and T. M. Stuart.

Tower & Wooden Tank Industrial Council.—The Council comprises the following companies: Challenge Co., Dunck Tank Works, Eagle Tank Co., Hauser-Stander Tank Co., Johnson & Carlson, U. S. Wind Engine & Pump Co., Wendnagel & Co. Rectangular tank, agitator, generator, film developing, crystallizing, filter tanks, tank with sloping bottom for drainage, model of sprinkler or gravity water supply tank, and burned-in lead-lined chemical tanks, each having a portion cut away so that details of construction may be studied. In charge of exhibit: Engineers of above mentioned companies.

Union Steam Pump Co.

Union Sulphur Co.—In charge of exhibit: W. N. Wilkinson and W. M. P. Taylor.

Union Thermometer Co.

United Filters — 4-1 type American filter with direct motor drive. A No. 2 size Sweetland filter constructed of aluminum, and a small model of a Kelly unit. A small United plate and frame press exhibited for the first time. Samples of cotton and metallic filter cloth for inspection of visitors. In charge of exhibit: C. B. Oliver, J. T. Hoyt and Winslow Souther.

United Lead Co., the **United Lined Tube & Valve Co.** and the **Raymond Lead Works**—United lead-lined iron pipe, valves, fittings and tin-lined valves and fittings. A new line of silver-lined valves, centrifugal acid pumps, Ulco hard metal. In charge of exhibit: L. B. Gallison and C. B. Holden.

U. S. Bureau of Mines—Exhibits from the various field offices of the Bureau and safety devices including the army gas mask. In charge of exhibit: M. F. Leopold.

U. S. Cast Iron Pipe & Foundry Co.—Photographs and samples of Usicast products. In charge of exhibit: H. A. Hoffer and J. D. Capron.

U. S. Industrial Alcohol Co. and **U. S. Industrial Chemical Co.**—Many uses of alcohol shown on an exhibit board. In charge of exhibit: B. R. Tunison.

U. S. Stoneware Co.—Representative pieces of standard chemical stoneware. In charge of exhibit: F. S. Wills and G. M. Wills.

U. S. Wind Engine & Pump Co.—(See Tower and Wooden Tank Industrial Council).

Universal Oil Co.

Universe Co.

Van Schaack Bros. Chem. Works.

Valley Iron Works, Appleton, Wis.—A small Vesuvius sulphur burner, a laboratory beating engine and a centrifugal acid-resisting pump. In charge of exhibit: W. H. Burns and R. A. Peterson.

Valley Iron Works, Williamsport, Pa.—A line of laboratory autoclaves ranging from 2⅔-qt. to 5½-gal. capacity and built for operating pressures up to 1000 lb. per sq.in. In charge of exhibit: R. L. Riley and Thomas Senior.

Virginia Smelting Co.

The Vitreous Enameling Co.—A full line of Vitreous enameled pans and trays. In charge of exhibit: Harry Warman and Charles E. Bullard.

Wallace & Tiernan Co.

Wedge Mechanical Furnace Works.

Wendnagel & Co.—(See Tower and Wooden Tank Industrial Council).

Werner & Pfleiderer Co. — Laboratory mixers and grinders. In charge of exhibit: Emil Staehle, J. C. Caley, C. Pletscher, S. D. Gridley, H. Gronbak and H. E. Gregor.

Western Reserve Chemical Co.

Westinghouse Electric & Manufacturing Co.—Industrial motors and control devices, fans, meters, heating appliances, circuit-breakers and switches.

Whitall Tatum Co.—Chemical glassware and laboratory apparatus. In charge of exhibit: J. F. Matthes.

J. G. White Engineering Corp.

The Whitlock Coil Pipe Co.—Working model showing the application of exhaust steam in heaters adapted to the chemical industries. In charge of exhibit: R. S. Bull, J. E. Chubb and E. B. Cole.

The Widney Co.—The Widney modulimeter for testing materials from steel to felt, rubber, paper, leather, etc. In charge of exhibit: S. W. Widney.

Wilson-Maeulen Co.—Indicating and autographic pyrometers, especially the multiple record tapalog and dust and fume proof pyrometer switches. In charge of exhibit: C. J. Brown, G. V. Nightingale and F. C. Baker.

Zapon Leather Cloth Co.

Zaremba Co.—Photograph and drawings of evaporator installations in many kinds of service in the chemical industries. In charge of exhibit: Edward Zeremba, W. H. Eggert, H. E. Jacoby and B. S. Hughes.

Zavon, Inc.

Natural and Industrial Resources of the North Central States

The natural resources of that group of North Central States comprising Illinois, Indiana, Michigan and Wisconsin are marked by both variety and abundance, as will be set forth in considerable detail throughout this issue of CHEMICAL & METALLURGICAL ENGINEERING. Certainly during the war the nation had reason to be thankful for the raw material and finished products which came out of this region.

By means of introduction to the details, which follow, we show opposite an industrial map of the region and give a few tables of condensed information.

The map shows the principal mineral products of the States and gives their relative rank among all similar deposits in the United States.

Table I, showing the mineral production of the Chicago District, was prepared by a local committee of the Chicago Section, A. I. M. E., for use in the souvenir guide book issued for the Chicago meeting of the Institute, Sept. 22-29. Tables II, III, and IV contain data compiled from the U. S. Census of Manufactures and give interesting comparisons on the manufacturing industries of the four States.

The census for 1919, now in preparation, will undoubtedly show a striking increase in all items in the four States.

TABLE II—RANK IN MANUFACTURING INDUSTRIES, 1904–14

	Wage Earners (Average No.)						Value of Products						Value Added by Manufacture					
	1914		1909		1904		1914		1909		1904		1914		1909		1904	
	Rank	Per Cent. Total	Rank	Per Cent. Total	Rank	Per Cent. Total	Rank	Per Cent. Total	Rank	Per Cent. Total	Rank	Per Cent. Total	Rank	Per Cent. Total	Rank	Per Cent. Total	Rank	Per Cent. Total
Illinois	5	7.2	4	7.0	4	6.9	3	9.3	3	9.3	3	9.5	3	9.2	3	8.9	3	9.1
Indiana	9	2.8	9	2.8	9	2.8	8	3.0	9	2.8	10	2.7	8	3.1	8	2.9	11	2.8
Michigan	7	3.9	7	3.5	8	3.2	7	4.5	7	3.3	8	2.9	7	5.0	7	3.7	7	3.2
Wisconsin	10	2.8	10	2.8	10	2.8	10	2.9	8	2.9	9	2.8	9	2.8	9	2.9	9	2.9

TABLE III—PER CENT INCREASE IN GROWTH OF MANUFACTURING INDUSTRIES, 1899-1914

	Wage Earners (Average Number)				Value of Products				Value Added by Manufacture			
	1904 to 1914	1909 to 1914	1904 to 1909	1899 to 1904	1904 to 1914	1909 to 1914	1904 to 1909	1899 to 1904	1904 to 1914	1909 to 1914	1904 to 1909	1899 to 1904
United States	28.7	6.4	21.0	16.0	63.9	17.3	39.7	29.7	37.0	15.8	35.5	30.3
Illinois	33.6	8.8	22.8	14.0	59.3	17.1	36.1	25.8	59.1	19.6	33.0	29.8
Indiana	28.1	5.6	21.3	10.9	85.5	26.2	47.0	16.9	77.0	25.4	41.1	22.2
Michigan	54.7	17.1	32.1	12.5	153.1	58.5	59.7	34.2	147.9	55.9	59.0	38.5
Wisconsin	28.3	6.4	20.6	10.1	69.1	17.8	43.6	25.8	51.1	13.9	32.7	30.4

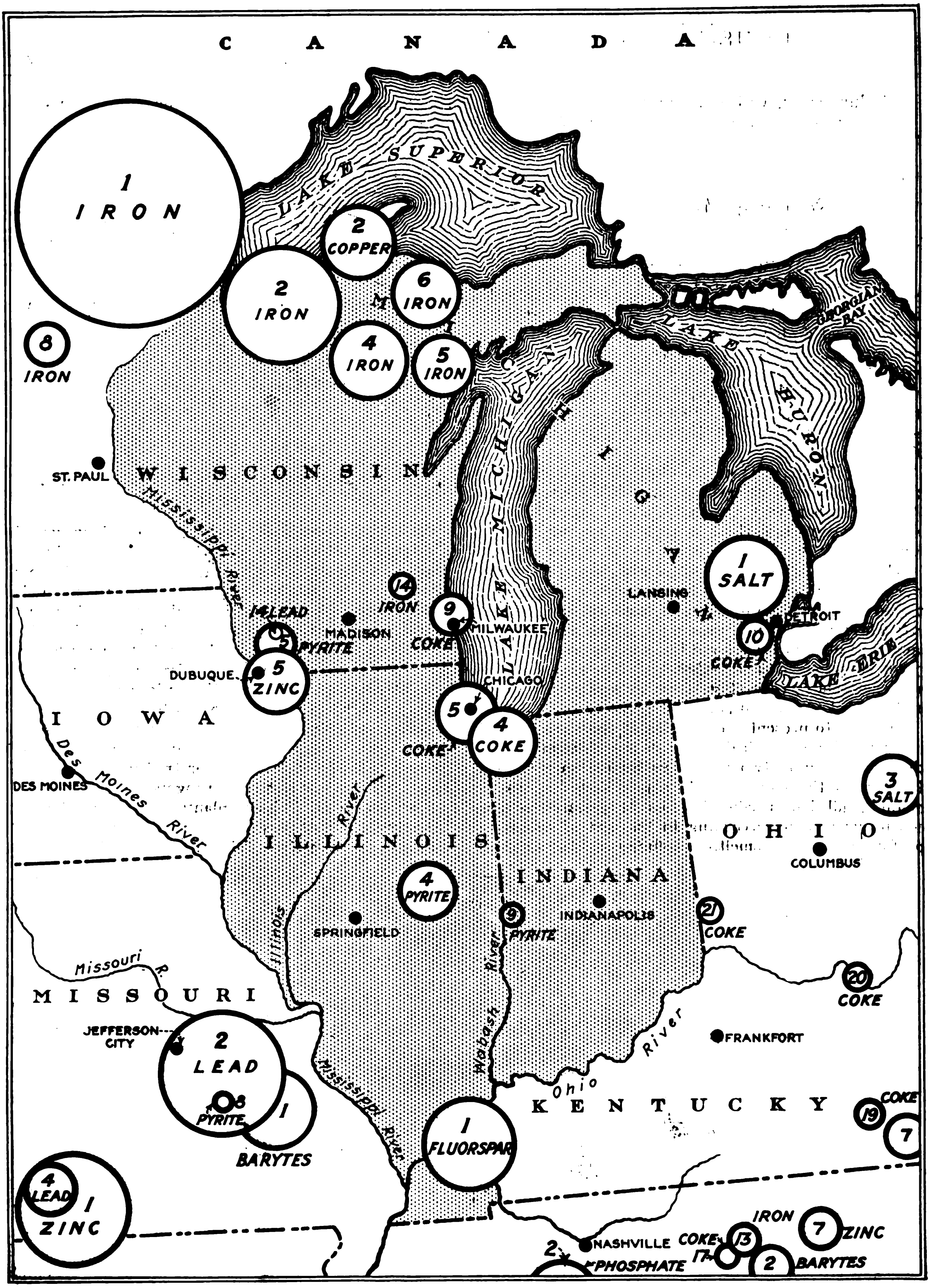
TABLE IV—VALUE OF PRODUCTS, 1899-1914

	1914	1909	1904	1899
United States	$24,246,434,724	$20,672,051,870	$14,793,902,563	$11,406,926,701
Illinois	2,247,322,819	1,919,276,594	1,410,342,129	1,120,868,308
Indiana	730,795,021	579,075,046	393,954,405	337,071,630
Michigan	1,086,162,432	685,109,169	429,120,060	319,691,856
Wisconsin	695,172,002	590,305,538	411,139,681	326,752,878

TABLE I—MINERAL PRODUCTION FOR 1917 OF THE CHICAGO SECTION DISTRICT (*a*)

Product	Illinois		Indiana		Michigan		Wisconsin		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Asphalt, short tons	110,756	$1,317,855	....	....	....	....	....	....	110,756	$1,317,855
Briquettes, fuel, short tons	....	....	....	....	....	....	*b c*	*b c*	....	....
Bromine, pounds	....	....	....	....	735,654	$405,059	....	....	735,654	405,059
Calcium chloride, short tons	....	....	....	....	22,679	294,693	....	....	22,679	294,693
Cement, barrels	*d*4,378,233	*d*6,090,158	*d*8,148,678	*d*$11,084,930	4,313,771	6,122,887	....	....	16,840,682	23,297,975
Clay products	....	19,565,420	....	10,999,474	....	4,034,245	....	$1,122,121	....	35,721,260
Clay-raw, short tons	195,693	789,589	73,863	78,463	5,746	13,627	*b c*	*b c*	....	....
Coal, short tons	86,199,387	162,281,822	26,539,329	52,940,106	1,374,805	4,426,314	....	....	114,113,521	219,648,242
Coke, short tons	2,289,833	*c*14,455,539	3,540,718	*c*21,831,302	*b c*	*b c*	*b c*	*b c*	....	....
Copper, pounds	....	....	....	....	255,710,128	69,808,865	....	....	255,710,128	69,808,865
Ferroalloys, long tons	*b c*	*b c*	....	....	....	....	....	....	....	....
Fluorspar, short tons	156,676	1,373,333	....	....	....	....	....	....	156,676	1,373,333
Gems and precious stones	....	....	....	....	....	95	....	....	....	95
Graphite, amorphous, short tons	....	....	....	....	*b*	*b*	....	....	....	....
Grindstones	....	....	....	....	....	*b*	....	....	....	....
Gypsum, short tons	....	....	....	....	375,803	1,568,655	....	....	375,803	1,568,655
Iron ore:										
Sold to furnaces, long tons	....	....	....	....	17,712,916	62,733,624	1,179,709	3,913,437	18,892,625	66,747,061
Sold for paint, long tons	....	....	....	....	1,445	*b*	982	*b*	2,427	....
Iron, pig, long tons	3,458,126	*c*91,094,541	2,162,872	*b c*	611,446	*c*18,300,501	402,732	*c*11,032,274	6,635,176	....
Lead, short tons	1,439	247,508	....	....	....	....	4,139	711,908	5,578	959,416
Lime, short tons	83,409	501,320	118,530	646,553	135,920	892,682	169,650	1,037,578	1,092,238	3,078,135
Magnesium, pounds	....	....	....	....	*b*	*b*	....	....	....	....
Manganiferous ore, long tons	....	....	....	....	52,198	*b*	....	....	52,148	....
Mineral paints (zinc and lead pigments), short tons	*b c*	*b c*	....	....	....	....	*b c*	*b c*	....	....
Mineral waters, gallons sold	1,370,461	66,042	521,758	152,469	1,069,164	105,641	6,296,634	1,362,498	9,258,017	1,686,650
Natural gas	....	479,072	....	453,310	....	1,013	....	....	....	933,395
Natural-gas gasoline, gallons	4,934,009	866,033	....	....	....	....	....	....	4,934,009	866,033
Oilstones and scythestones	....	....	....	27,693	....	....	....	....	....	27,693
Peat, short tons	*b*	*b*	*b*	*b*	....	....	....	....	....	....
Petroleum, barrels	15,776,860	31,358,069	759,432	1,470,548	*b*	*b*	....	....	....	....
Potash, short tons	*b*	*b*	....	....	381	299,395	277	259,928	....	....
Pyrite, long tons	24,596	89,998	*b*	*b*	....	....	*b*	*b*	....	....
Salt, short tons	....	....	....	....	2,250,939	6,877,202	....	....	2,250,939	6,877,202
Sand and gravel, short tons	9,120,698	3,658,799	5,906,196	1,591,158	3,814,445	1,641,748	3,609,869	1,080,860	22,451,208	7,972,565
Sand and sandstone (finely ground), short tons	386,866	630,256	....	....	....	....	....	....	386,866	630,256
Sand-lime brick	....	....	....	60,201	....	370,723	....	*b*	....	....
Scythestones	....	....	....	....	....	*b*	....	....	....	....
Silica (quartz), short tons	....	....	....	....	*b*	*b*	*b*	*b*	....	....
Silver, fine ounces (Troy)	7,186	5,921	....	....	688,551	567,366	....	....	695,737	573,287
Stone	....	3,322,041	....	4,449,809	....	3,423,825	....	2,787,023	....	13,982,698
Sulphuric acid, short tons(*e*)	....	3,902,831	*b*	*b*	....	....	*b*	*b*	....	....
Tripoli	....	31,338	....	....	....	....	....	....	....	31,338
Zinc, short tons	4,267	870,468	....	....	....	....	59,742	12,187,368	64,009	13,057,836
Miscellaneous (*f*)	....	6,343,662	....	51,582,551	....	5,791,496	....	9,017,291	....	72,735,000
Total values, eliminating duplications	....	$236,934,22	....	$85,079,370	....	$163,997,853	....	$24,976,780	....	$510,988,232

a. Published by permission of the Director of the United States Geological Survey subject to final revision.
b. Value included under "Miscellaneous."
c. Value not included in total value.
d. Exclusive of natural cement, value for which is included under "Miscellaneous."
e. From zinc smelting.
f. Natural cement, ferroalloys, zinc and lead pigments, peat, potash, pig iron, pyrite, sulphuric acid from zinc smelting, coke, amorphous graphite, grindstones, iron ore sold for paint, magnesium, manganiferous ore, petroleum, scythestones, silica (quartz), fuel briquettes, raw clay, and sand-lime brick.


CANADA
1 IRON
2 COPPER
2 IRON
6 IRON
4 IRON
5 IRON
8 IRON
LAKE SUPERIOR
LAKE HURON
GEORGIAN BAY
LAKE MICHIGAN
MICHIGAN
WISCONSIN
ST. PAUL
Mississippi River
14 IRON
14 LEAD
5 PYRITE
MADISON
9 COKE
MILWAUKEE
1 SALT
LANSING
DETROIT
10 COKE
LAKE ERIE
DUBUQUE
5 ZINC
CHICAGO
5 COKE
4 COKE
IOWA
DES MOINES
Des Moines River
3 SALT
ILLINOIS
Illinois River
OHIO
COLUMBUS
4 PYRITE
INDIANA
INDIANAPOLIS
SPRINGFIELD
9 PYRITE
21 COKE
Wabash River
Missouri R.
MISSOURI
20 COKE
FRANKFORT
Ohio River
JEFFERSON CITY
2 LEAD
8 PYRITE
1 BARYTES
1 FLUORSPAR
KENTUCKY
19 COKE
7
4 LEAD
1 ZINC
IRON
7 ZINC
NASHVILLE
13 COKE
2 PHOSPHATE
2 BARYTES

RESOURCE MAP OF THE NORTH CENTRAL STATES

The figures in the circles show the relative rank among all similar deposits in the United States. Adapted from a complete map of the United States prepared by the Nashville Section, Engineering Association of the South.

Industrial Resources of the Chicago District

Metallurgically, Chicago Ranks Second Only to Pittsburgh as a Producing Center, While in Non-Ferrous Operations Refining and Alloying Are Extensively Represented — Oil Refining and Packing House Products Represent the Most Extensive Chemical Interests

Non-Ferrous Metallurgy in the Chicago District

BY H. B. PULSIFER

NOT infrequently we have asserted and defended the statement that Chicago is the very greatest metallurgical center on the globe. Pittsburgh with its pre-eminence in iron and steel has to be considered, but with Pittsburgh the argument largely ends with the great iron and steel plants; Chicago comes second in iron and steel, but its real claim to greatness is in the abundance and variety of the non-ferrous metallurgical plants.

In the Chicago district one finds 35 great plants of prime importance, as well as over 200 foundries. In 1917 the author, with his students at Armour Institute of Technology, undertook a sort of census of these foundries in the Chicago district. It was desired to check up the current lists of plants, note the sort of work and equipment at each, the number of men employed as well as the presence of technical men, and the attitude toward using graduates. The results were amazing: plants employing a thousand or more men had never before come to our attention. The range of work surprised one: every stage from antipathy to full use of technical talent had several representatives.

In order to present a clear idea of the varied metals and processes one will discover in the Chicago district, the accompanying two lists have been prepared. List I arranges the more notable plants according to the metal handled or produced. List II groups the more conspicuous plants according to the sort of operations performed, such as smelting, refining or electroplating

It is frankly admitted that the lists are incomplete; in fact, the author has never started out on a metallurgical exploring trip about the great inland metropolis without abundant discoveries as to plants, metals and processes.

Surprisingly large and diversified amounts of ores and concentrates come to Chicago for treatment. Instances of this sort have been Butte zinc concentrates and Wisconsin zinc concentrates for roasting, Boss platinum ores from Nevada, lead concentrates from Wisconsin, antimony ores from South America, gold bullions from cyanide plants, lead bullions from Mexico, sweepings from the United States and Canadian mints.

CHICAGO PRE-EMINENT IN SECONDARY METAL RECOVERY

It is in the secondary metal recovery, however, that Chicago probably ranks as pre-eminent. This business amounts to many millions of dollars a year. Scrap and junk metal is reclaimed in the usual furnaces and by similar processes as virgin metal, again going on the market indistinguishable from metals and alloys direct from ores. The abundance of almost every sort of scrap metal makes it profitable to make brass, bronze, solders, babbitts and various other alloys from reclaimed stock, possibly adding some fresh stock to bring to specification. One dare not say that gold bars from sweepings are less pure than bars from cyanide mills or that brass from scrap copper trolley wire is inferior to brass from new electrolytic ingots.

Certain of the Chicago plants are always doing interesting and notable work. The Western Electric Co., Crane & Co., the Great Western Co., Goldsmith & Co.,

Photo copyright, Underwood & Underwood, N. Y.

SKYLINE OF CHICAGO—GRANT PARK IN THE FOREGROUND

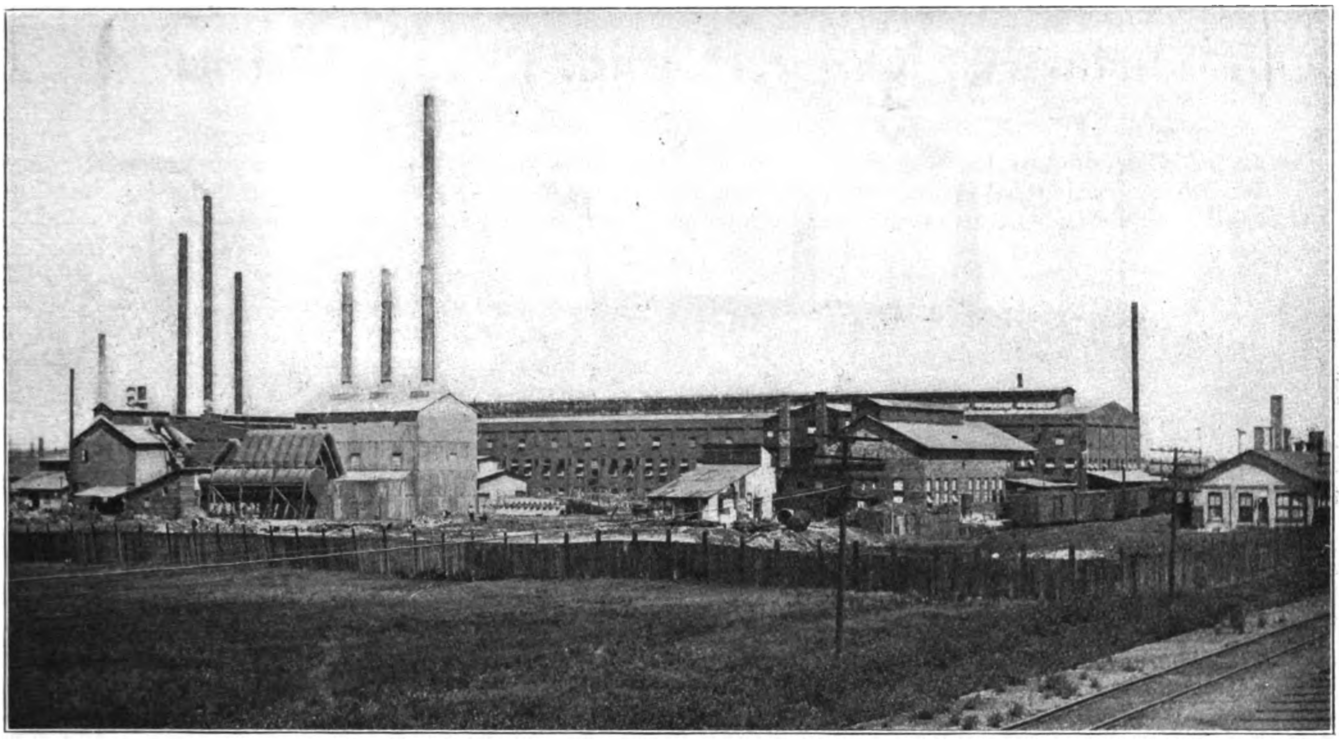


FIG. 1. THE UNITED STATES METALS REFINING PLANT AT EAST CHICAGO

the International Lead Co., the United States Co., the International Harvester Co. and the National Lead Co. may each have a dozen furnaces on the most varied work. Oxide copper furnaces are at work just as they used to be in Arizona during the '80s, and the slags are high in copper, too. Small copper reverberatories are getting out tough pitch copper just as the big furnaces do at Great Falls and Perth Amboy. Lead blast-furnaces are making bullion and matte just as they do in the West; one of the neatest bag houses is right in the heart of the city, and another fine example is at East Chicago.

It can hardly be held that much of the plant work is less metallurgical because it is joined up with metal preparation and manufacturing processes. Most of the Chicago plants add to the smelting, refining, graining and shaping of the metals also the final factory operations which put the stock on the market for ultimate consumption. Thus the Goldsmith plant is fundamentally a precious-metal plant, but the company is also widely known as furnishing dental specialties. The National Lead Co., with all its furnaces, alloying and extrusion work, is better known as supplying pigments

LIST I—METALS PRODUCED, REFINED AND PREPARED IN THE VICINITY OF CHICAGO

Iridium	Goldsmith Bros. S. & R. Co.
Palladium	Goldsmith Bros. S. & R. Co. Thomas J. Dee & Co.
Platinum	Goldsmith Bros. S. & R. Co. Thomas J. Dee & Co.
Gold	Goldsmith Bros. S. & R. Co. Thomas J. Dee & Co. Alexander Cassriel Co.
Silver	Goldsmith Bros. S. & R. Co. Thomas J. Dee & Co. Alexander Cassriel Co.
Tungsten	The Pfanstiehl Co.
Tin	Metal & Thermit Corporation
Bismuth	United States Metals Refining Co.
Aluminum	United States Reduction Co. Castings made in score of foundries.
Copper	Great Western S. & R. Co. Chicago Bearing Metal Co. Goldsmith Bros S. & R. Co.
Lead	United States Metals Refining Co. International Lead Refining Co. Goldsmith Bros. S. & R. Co. National Lead Co. Carter White Lead Co. Great Western S. & R. Co. Raymond Lead Co.
Brass and bronze	Made, cast and worked in scores of foundries and plants.
Solders	Great Western S. & R. Co. National Lead Co.
Babbitts	Great Western S. & R. Co. National Lead Co. Fort Dearborn S. & R. Co.
Hard lead	International Lead Refining Co. United States Metals Refining Co. Great Western S. & R. Co. National Lead Co.

LIST II—METALLURGICAL OPERATIONS ACTIVELY PROSECUTED IN THE VICINITY OF CHICAGO

Concentrating	Jigs, tables and fine grinding mills are found in connection with several foundries.
Leaching	Few instances in strictly metallurgical works, common in the chemical plants.
Roasting	Grasselli Chemical Co. has two standard Hegeler zinc roasting furnaces in constant use. Goldsmith Bros. S. & R. Co. has a Dwight-Lloyd roast-sintering machine.
Smelting	Chicago Bearing Metal Co. International Lead Refining Co. United States Metals Refining Co. Goldsmith Bros. S. & R. Co. National Lead Co. Great Western S. & R. Co.
Refining	International Lead Refining Co. United States Metals Refining Co. Goldsmith Bros. S. & R. Co. Great Western S. & R. Co. Thomas J. Dee & Co.
Dissolving	Grasselli Chemical Co. Goldsmith Bros. S. & R. Co.
Bag Houses	International Lead Refining Co. Goldsmith Bros. S. & R. Co. United States Metals Refining Co.
Cupelling	International Lead Refining Co. United States Metals Refining Co. Goldsmith Bros. S. & R. Co. Thomas J. Dee & Co.
Granulating	Carter White Lead Co. Goldsmith Bros. S & R. Co.
Briquetting	Metal Block & Ingot Co.

Rolling, Drawing, Spinning, Extruding, Wire Drawing, Pressing and Stamping of most common metals practiced in scores of plants.

Casting of iron, steel, brass, bronze and aluminum carried out in over 200 foundries.

Electroplating carried out in more than a dozen large plants.

Metallographic Laboratories	Illinois Steel Co. Robert W. Hunt & Co. Armour Institute of Technology.
Analytical and Consulting Laboratories	Robert W. Hunt & Co. Kawin & Co. Columbus Laboratories. Armour Institute of Technology. Indiana Laboratories.
School	Armour Institute of Technology.

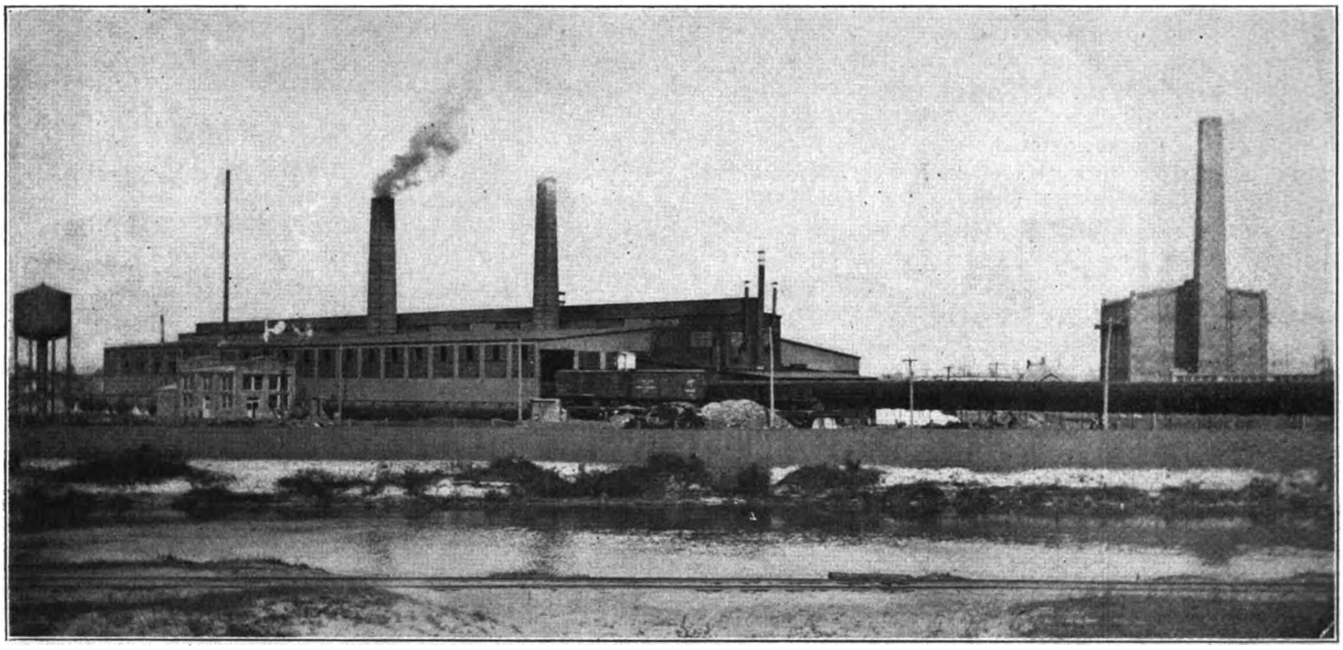


FIG. 2. THE INTERNATIONAL LEAD REFINING CO.'S PLANT AT EAST CHICAGO

and paint. The Grasselli Chemical Co., with its roasters and metal dissolving facilities, is known rather as supplying acids and salts. A certain large manufacturing jeweler employing 50 or 60 men in a corner of one floor of a huge office building is apparently only busy at making rings and pins and setting precious stones, but really he is even more fundamentally interested in alloying, deoxidizing, hardening, shaping, electroplating and reclaiming scrap and sweepings. The International Harvester Co. makes and sells farming implements, but we would consider it a rather large metallurgical plant which operates 4 cupolas, 8 air furnaces and numerous brass furnaces.

THE UNITED STATES METALS REFINING CO.

The United States Metals Refining Co. has possibly the most important and interesting plant near Chicago, excluding the steel plants. This is an electrolytic lead refinery; base bullion from the West is the chief raw material, electrolytic lead and pure bismuth are the two chief finished products. The precious metals in the form of doré slabs are sent to Chrome, N. J., for final separation and purification. Besides the immense tank house and remarkable electrolytic work, the plant produces hydrofluoric acid and hard lead alloys. In the recent death of William Thum, long superintendent of the plant, not only the community loses a strong and able character but the metallurgical world a penetrating investigator and constructive scientist. The plant has accomplished much in the refining of lead, the treatment of the electrolytic slime and the winning of the very purest bismuth. Our view of the plant in Fig. 1 shows the immense tank house in the rear with the (from the right) office, fluosilicate building, bag house and blast-furnace building across the foreground.

THE INTERNATIONAL LEAD REFINING CO.

The International Lead Refining plant was built at East Chicago under the direction of George Hulst, a very capable manager in the lead refining business. This is the most modern of the world's lead refineries using the Parkes process. It is the lead refining department of the Anaconda Copper Mining Co. At the right in Fig. 2 one sees the striking bag house, while the main furnace building is at the left. The plant has never really been pushed to capacity and is designed for expansion to much larger size. Besides operating it at remarkably efficient cost, Hulst has done much interesting work in smelting antimony ores for the hard-lead trade.

The Goldsmith plant is possibly the most versatile in the whole district. Precious metal values are recovered from concentrates, ores, residues and sweepings by sintering, smelting and the Parkes process of desil-

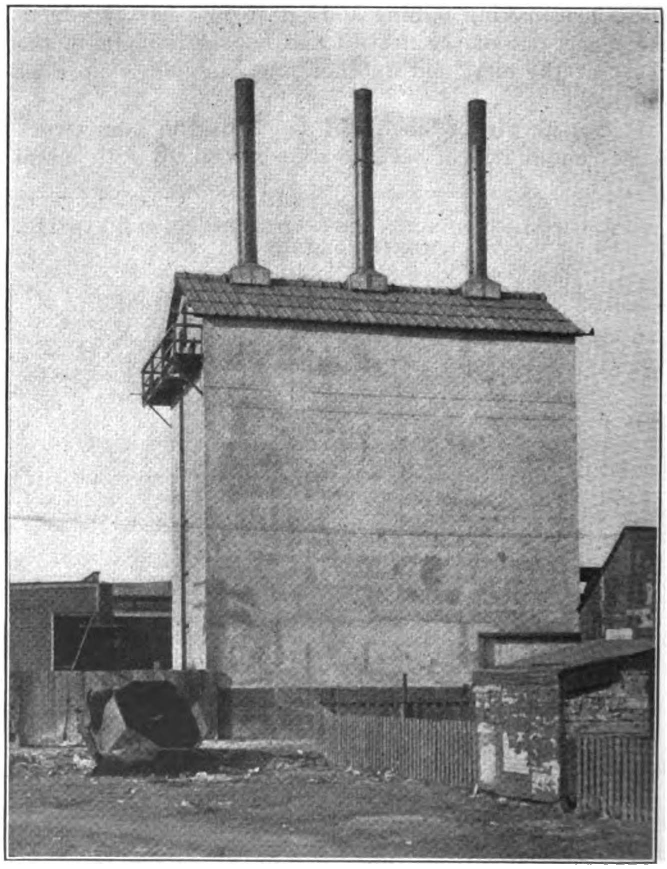
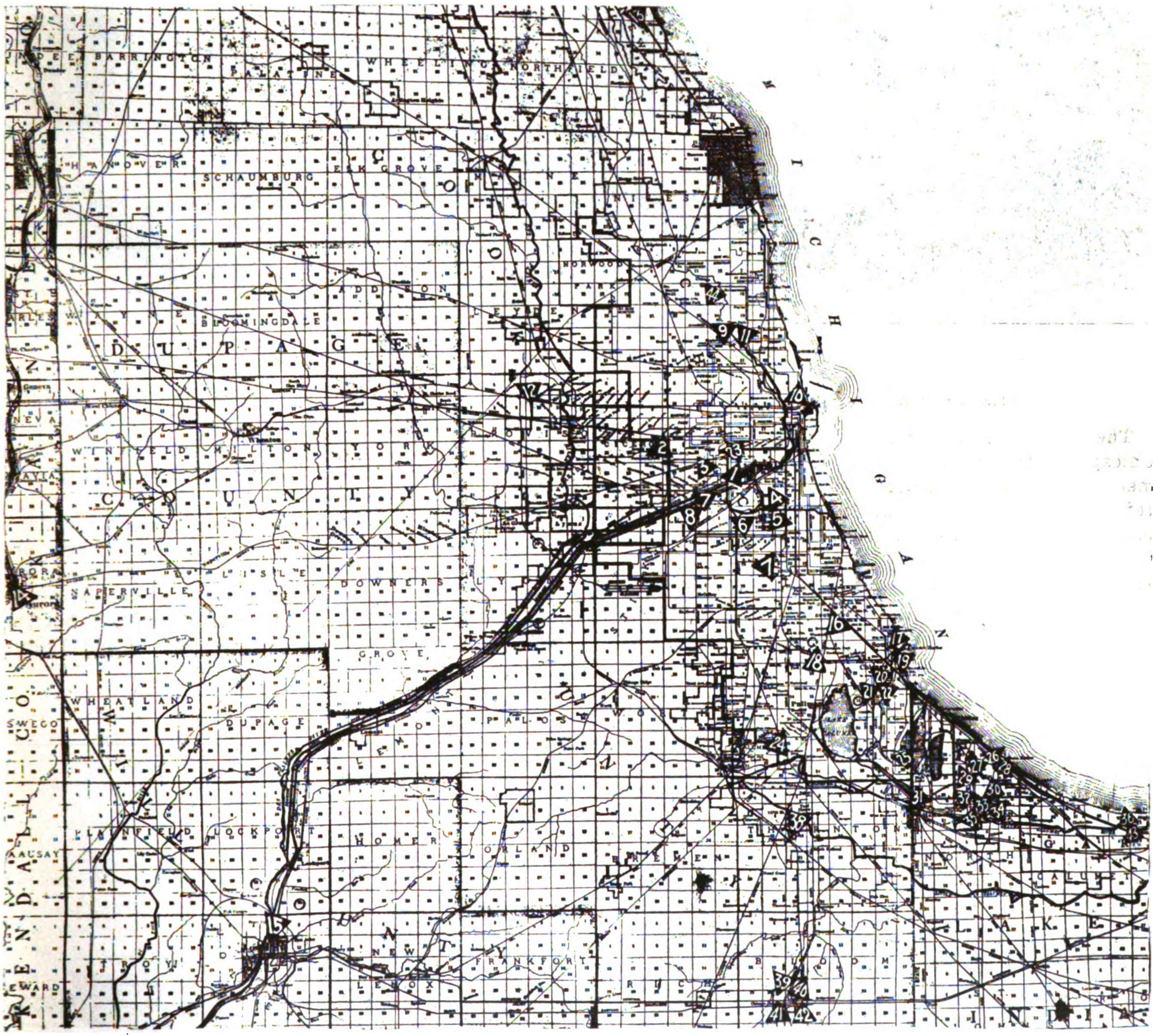


FIG. 3. THE GOLDSMITH BAG HOUSE, 58TH AND THROOP

verization. Precious metal parting is performed by acids and pure iridium, palladium, platinum, silver and gold are produced. Iridium is marketed as powder or in hard platinum, but the other metals are melted and sent out in bars, rolled plate, granulated or as salts. A unique copper-dissolving tank used in the manufacture of blue stone, a model bag house (Fig. 3) and improved chemical laboratory were features designed by the author. The plant manufactures a splendid line of dental cements, largely the product of an Armour Institute graduate. Osmic acid, silver chloride and silver nitrate, gold chloride and blue stone are further plant products. Fig. 4 is a view in the melting room; 18-in. dishes for parting gold bullions are on the table and a wheelbarrow of silver is at the right. The silver is melted in the crucible furnace at the right and the parting done in the oven behind the two men. The diagram of the plant as given in Fig. 5 indicates the spread of the plant; it has recently been largely rebuilt.

GREAT WESTERN SMELTING & REFINING CO.

The Great Western Smelting & Refining Co. plant is equipped with machines for grinding, washing and briquetting metallic residues. There is one cupola, or blast-furnace, and reverberatories for matte, solder, lead, brass, copper and copper refining. There are eight pit furnaces for crucibles, a sweating furnace and three large melting kettles. Precious metal residues are not handled, but otherwise the plant reclaims most of the non-ferrous wastes of civilization and turns out a long list of metals and alloys. An adequate laboratory enables work of precision to be done.



LOCATION OF THE MORE PROMINENT METALLURGICAL PLANTS IN THE CHICAGO DISTRICT

1—International Harvester Co. 2—National Malleable Castings Co. (Laramie Ave. plant). 3—National Malleable Castings Co. (Rockwell Street plant). 4—Link-Belt Co. 5—Great Western S. & R. Co. 6—Chicago Bearing Metal Co. 7—Chicago Steel Foundry Co. 8—Crane Co. 9—Metal Block & Ingot Co. 10—Thomas J. Dee & Co. 11—Illinois Malleable Iron Co. 12—National Malleable Castings Co. (Melrose Park plant). 13—The Pfanstiehl Co. 14—Aurora Metals Co. 15—Illinois Steel Co. (Joliet plant). 16—Interstate Iron & Steel Co. 17—Illinois Steel Co. (South works). 18—Burnside Steel Co. 19—Sheet & Tube Co. of America (Iroquois plant). 20—Pollak Steel Co. 21—Wisconsin Steel Co. 22—By-Products Coke Corp. (Federal furnaces). 23—National Lead Co. 24—Chicago Malleable Castings Co. 25—General Chemical Co. 26—Inland Steel Co. 27—American Steel Foundries Co. 28—Sheet & Tube Co. of America (Mark plant). 29—Sheet & Tube Co. of America (East Chicago plant). 30—United States Metals Refining Co. 31—Hammond Malleable Castings Co. 32—Republic Iron & Steel Co. 33—Metal & Thermit Corp. (Goldschmidt plant). 34—Grasselli Chemical Co. 35—International Lead Refining Co. 36—Indiana Steel Co. (Gary plant). 37—Goldsmith Bros. S. & R. Co. 38—Universal Draft Gear Co. 39—American Manganese Steel Co. 40—Columbia Tool Steel Co. 41—Railway Steel Spring Co. 42—Calumet Steel Co. 43—Union Drawn Steel Co. 44—Chicago Metal Treating Co.

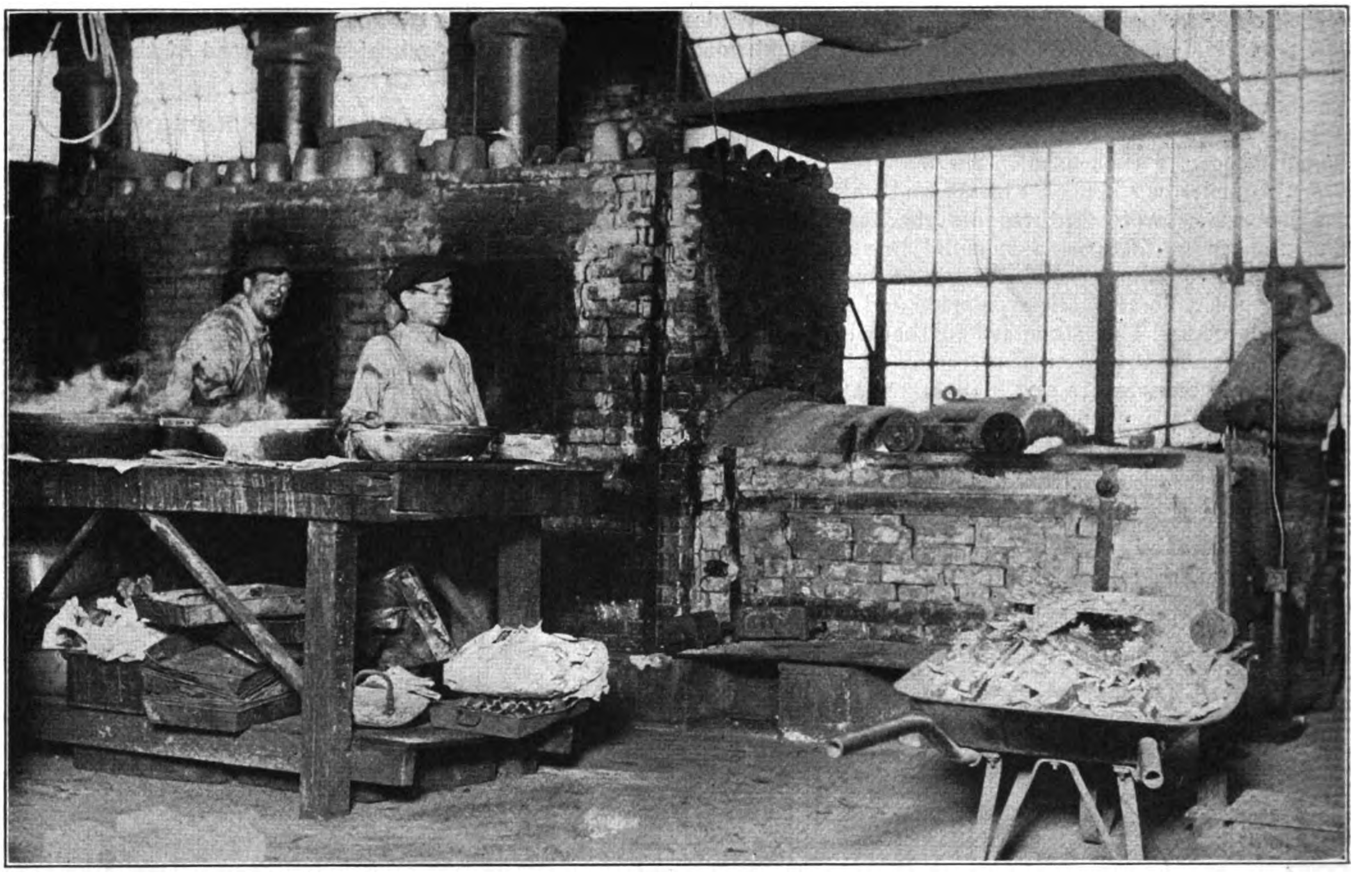


FIG. 4. VIEW IN THE MELTING ROOM AT GOLDSMITH'S

THE THOMAS J. DEE PLANT

The Thomas J. Dee plant is on the North Side of Chicago, a small heavily barred strong-box for precious metal work. Furnaces are installed for melting and refining the precious metals, while the acid process is used for parting. Besides turning out bars and slabs, the plant features drawing precious metals into wire. After the short, thick rods are cast they are swaged down and then drawn through dies to specified size. Gold, silver, platinum and their alloys are thus treated for the market.

It is obvious that Chicago is a great lead refining center and a heavy producer of the precious metals, either pure or alloyed. It is also a conspicuous center for the antimony-lead alloys, bismuth, the copper and tin bearing metals, and solders. A large portion of this business comes through the smelting, refining and alloying of junk materials.

The most conspicuous voids in the general metallurgical field result from the absence of much virgin ore reduction, leaching operations, electrolytic copper refining and zinc smelting. For the electrolytic copper refining one must go far, either West or East, but for the zinc smelting a short trip to LaSalle and DePue puts one among the greatest plants.

School of Mines,
Butte, Montana.

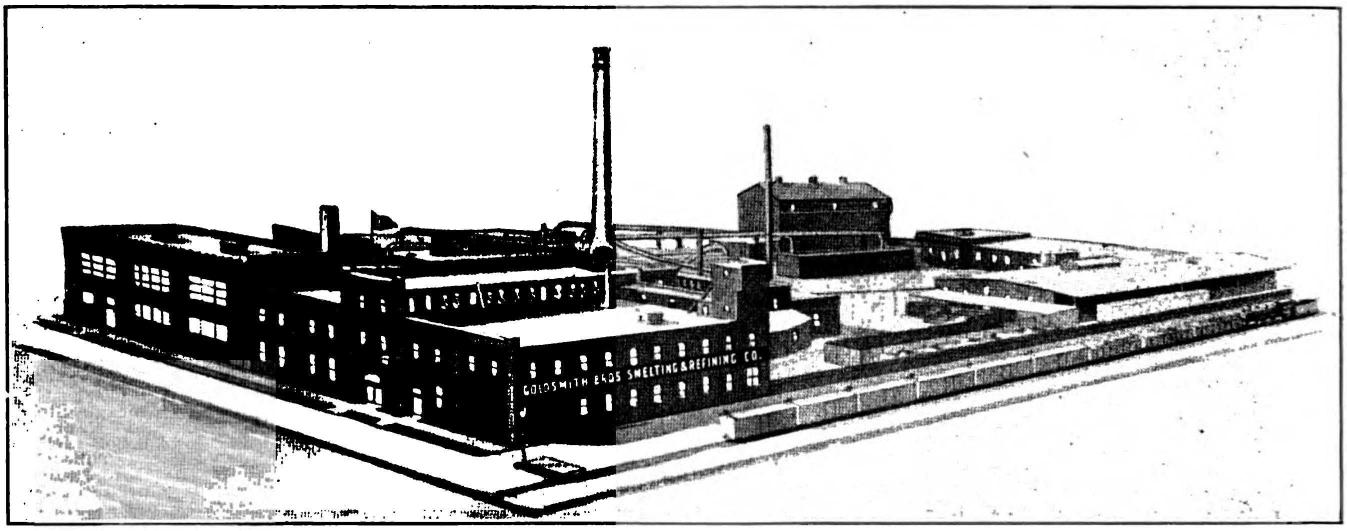

GOLDSMITH BROS SMELTING & REFINING CO.

FIG. 5. DIAGRAM OF THE GOLDSMITH PLANT: MORE RECENTLY MUCH REBUILT AND IMPROVED

Chemical Industries of Illinois and the Chicago District

BY PROCTER THOMSON

THE fortunate geographic location of Chicago has led to the development of a wonderful system of transportation facilities. This consists not only of the numerous railways which radiate from Chicago in every direction, but includes the various belt lines and clearing yards which facilitate the movement of goods from one railroad to another. The coal fields of Illinois and Indiana insure a plentiful and sure supply of fuel at low cost. When Eastern cities are tied up with freight congestion, Chicago has found it possible to obtain raw materials and fuel and to ship finished goods. The appreciation of these factors is leading to the development of Chicago as an industrial center. This development has extended beyond the border of Illinois and over into Indiana. As these northern Indiana industries are in the Chicago district, they will be considered here instead of with Indiana industries. Chemical industry has taken part in this growth in a greater degree than is generally known.

The chemical industry of Illinois other than the Chicago district is considerable. It participates in the transportation advantages of Chicago, but is generally the result of nearby sources of raw material. This is particularly the case of the zinc industry with the associated acid plants.

BY-PRODUCT COKE PLANTS

Illinois has unlimited supplies of limestone and fluorspar, which, in addition to the factors already named, contribute to the growth of the iron and steel industry, which has reached great proportions and is still growing.

The Interstate Iron & Steel Co. has four open-hearth furnaces at South Chicago.

Closely associated with iron and steel is the by-product coke industry. This has reached tremendous proportions. The United States Steel Corporation has 700 Koppers ovens at Gary and 280 Koppers ovens at Joliet. The total coking capacity of these ovens is 12,000 tons of coal per day.

The By-Products Coke Corporation operates 280 Semet Solvay ovens at South Chicago and has 120 more nearly ready to operate at Indiana Harbor. The combined capacity of these 400 ovens will be 45,000 tons of coke per month.

MISCELLANEOUS METALLURGICAL INDUSTRIES

Most of the metallurgical activity in the Chicago district other than iron and steel is in the refining of trade wastes. There are notable exceptions to this, however. One of these is the Fansteel Products Co. This company at North Chicago is producing metallic tungsten, molybdenum, and cerium of great purity. The tungsten is produced from wolframite, and the molybdenum from ammonium molybdate or molybdic oxide. The processes are practically the same for both metals. The raw material is fused with sodium carbonate, the soluble salts of the metals leached out, and by alternate precipitation with acid and solution in alkali, with the accompanying filtering and washing, oxides of a high degree of purity are produced. After ignition the oxides are reduced by hydrogen. The metallic powder is pressed into bars and sintered electrically. These bars are then swedged into the desired shape. The tungsten is cut into discs and mounted on the proper supports for electrical-contact apparatus. The molybdenum is used in the manufacture of spiders for tungsten filaments. Metallic cerium is produced from materials obtained from the Lindsay Light Co. A pure cerium chloride is made which is fused and electrolyzed and metallic cerium recovered. This is used in pyrophoric alloys.

PAINT PIGMENT

The manufacture of paint pigments is carried on at a number of plants in Illinois. Lithopone is manufactured by Sherwin-Williams at Pullman, the Midland Chemical Co. at Argo and the Consolidated Chemical Products Co. at Alton. The Sherwin-Williams Co. manufactures corroded white lead and dry colors, including prussian blue, chrome yellow and para toners.

The National Lead Co. has a large plant producing corroded white lead by the old Dutch process, red lead and litharge. Here also, babbitts, solder and metals for tempering baths, etc., are produced.

The Carter White Lead Co. produces white lead in South Chicago.

HEAVY AND INORGANIC CHEMICAL MANUFACTURE

The field of heavy and inorganic chemical manufacture is well taken care of by Illinois and the Chicago district. The General Chemical Co., with factories at South Chicago, Chicago Heights and East St. Louis, manufactures a general line of heavy chemicals, including mineral acids, sodium sulphide, zinc chloride, silicate of soda, aluminum sulphate, soda alum and contact sulphuric acid.

The Grasselli Chemical Co. manufactures heavy chemicals at East Chicago.

The Central Chemical Co. at West Hammond, Ill., produces brimstone sulphuric acid, hydrochloride acid and nitric acid.

One of the most interesting developments in Chicago is the Lindsay Light Co., which originally was a producer of incandescent mantles for gas lights, but market conditions in 1914 led it to become a producer of the basic materials used in the mantle industry. The raw material used is monazite sand from India. From this the company is producing thorium nitrate, cerium salts and titantium potassium oxalate. It is almost alone in this field. Beryllium and antimony salts are also being produced. Since the signing of the armistice it has been preparing for the production of dyestuffs and will soon be in the market with phthalic anhydride, phenolphthalein, methylene blue, fuchsine and other products of like nature.

Most people think of borax as being produced in the region where raw materials are found. The Thorkildsen-Mather Co., however, finds conditions in Chicago so favorable to chemical industry that it has located its factory here. It produces borax in the stockyards district from California colemanite.

The production of radium compounds is also being carried on in Chicago—the Carnotite Reduction Co. is producing radium bromide and vanadium compounds from Colorado carnotite.

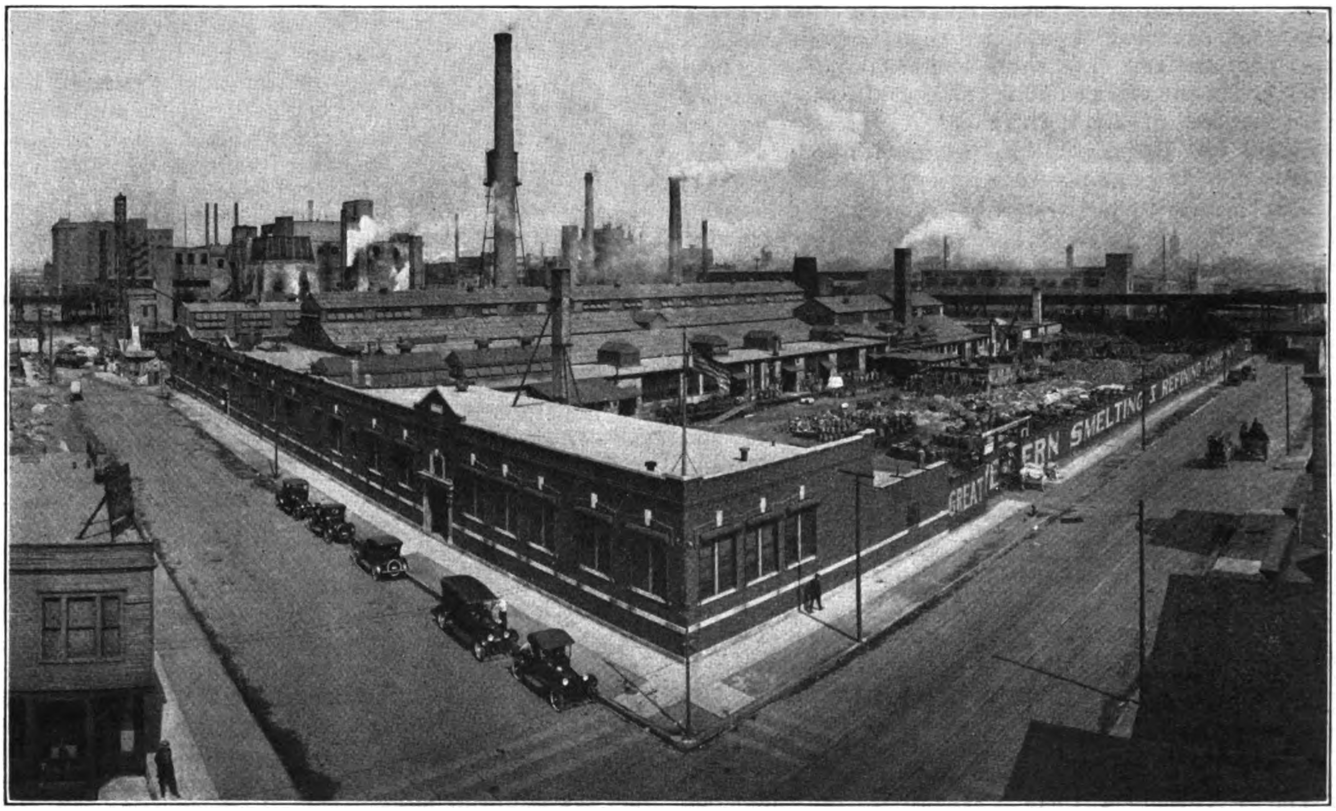
The Superior Chemical Co. at Joliet is making filter alum, cream of tartar substitute and soda alum, using Arkansas bauxite. Located near by is the Superior Phosphate Co., manufacturer of calcium phosphates.

Stiesen-Reuter & Hancock are producing metallic salts and soaps of lead, manganese, cobalt, iron and zinc, also aluminum salts and calcium and magnesium stearate and oleate.

The Chicago Copper & Chemical Co. produces barium salts, glaubers salts and sodium sulphide.

The Victor Chemical Co. has a large plant at Chicago Heights. Among other products, the company manufactures at the present time monocalcic and dicalcic phosphate, monosodium and disodium phosphate, monoammonium and di-ammonium phosphate, phosphoric acid, epsom salts, sulphuric acid and oxalic acid. Oxalic acid is one of the latest additions to its line and is made by the synthetic process, which is claimed to produce an acid of superior strength and purity.

The Dearborn Chemical Co. has found Chicago a most convenient place to build up an extensive business in boiler compounds and water treatment. It is also manufacturing an interesting rust inhibitor, which consists of a petrolatum-like product with the rust-inhibiting compounds emulsified therein.



GREAT WESTERN SMELTING & REFINING CO. PLANT

The Illinois Match Co. has a factory at Joliet.

The Illinois Glass Co. has a large plant at Alton and a small one at Chicago Heights, Ill., for the production of bottles. The glass at the Alton plant is produced by the continuous process. New equipment has been developed for this plant for the machine blowing of very large bottles.

PACKING-HOUSE CHEMICAL INDUSTRIES

The location of packing-house interests in Chicago has led to the growth of extensive chemical manufacturing along the lines of soap, glue, glycerine, fertilizers, etc. All of the packers are working with cottonseed, soya bean and other vegetable oils in addition to the fats. It is interesting to note that not all of the packers do the same things. They appear to differ in their opinions as to the advisability of certain chemical manufactures.

Armour & Co. manufacture anhydrous ammonia, soap, glue, glycerine, fatty acids, animal fertilizers (tankage, bone meal), acid phosphate and rock phosphate. They refine and hydrogenate oils for lard substitutes, etc.

Morris & Co. make anhydrous ammonia, glycerine, fatty acids and refined and hydrogenated oils.

Swift & Co. manufacture soap, glycerine, fatty acids, glue, acid phosphate and mixed fertilizers, refined and hydrogenated oils, and oxygen.

The chemical activities of Wilson & Co. are confined to refining and hydrogenating oils, manufacturing fertilizers and glue.

Abbatoir pharmaceuticals are manufactured by Armour & Co. and by the Hollister-Wilson Co., which has just completed a new plant. Both firms manufacture digestive ferments, organic extracts and organotherapeuticals.

There are a number of soap manufacturers in Chicago who operate independently of oil or fat manufacture. Typical of these are Fitzpatrick Bros., James S. Kirk & Co. and the Allen B. Wrisley Co.

Similarly situated are glue and fertilizer manufacturers who purchase their raw materials from various sources. The United Chemical & Organic Products Co. at West Hammond, Ill., manufactures gelatine, glue, fertilizers, etc.

Chicago has a great number of tanners. Most of them are conducting operations by rule-of-thumb methods, so they cannot really be classed as chemical industries.

Not to be classed as a packing-house activity but closely associated in character is cottonseed oil refining. The American Cotton Oil Co. and the N. K.

Fairbank Co. have a large plant in Chicago for the refining of oils. Their principal source is the cottonseed oil from their own mills in the South. Here they refine and hydrogenate cottonseed and other vegetable oils and distill fatty acids, producing soap products, glycerine, lard compounds, cooking oil and salad oil. It is especially interesting to note that the American Cotton Oil Co. has established a research department which is on an equal basis with the production department and sales department. Research for all of the plants is carried on here.

MISCELLANEOUS ORGANIC INDUSTRIES

The Corn Products Refining Co. has a large factory at Argo. Here it produces starches, dextrines, corn syrup, corn sugar and corn oil for industrial purposes, as well as salad and cooking oil.

The Redmanol Chemical Co. produces its anhydrous phenol resin. Using this as a base it molds a great variety of products ranging from cigar holders to electrical insulating materials. It has recently perfected a cold molding compound.

The Abbott Laboratories was originally a producer of alkaloids for medical use. In addition to the extraction and purification of alkaloids it now manufactures a number of synthetic organic pharmaceuticals. These include the Dakin antiseptics—chlorazene, dichloramine T, chlorcosane (a solvent for dichloramine T) and halazone. It is also producing procaine (novocaine) and dimethyl barbituric acid (veronal).

Burke & James sensitize photographic paper and films.

The Carus Chemical Co. in La Salle, Ill., manufactures saccharine, chloramine T and potassium permanganate.

An interesting plant, which has duplicates at other points in the United States, is the carbon dioxide plant of the Liquid Carbonic Co. Here power is obtained as a by-product. Coke is burned under boilers, the flue gas is scrubbed with water and absorbed in alkaline solution in large absorbing towers. The solution is then heated, the CO_2 driven off, collected, and compressed to 1000 lb. per sq.in. in cylinders. The steam produced by burning the coke runs the compressor and leaves a surplus for other purposes.

The Peoples Gas Light & Coke Co. has installed four light oil reclaiming plants to save the benzene, toluene, etc., produced in its water gas plants. The recovered oil is refined at its central refinery and various grades of benzol, toluol, solvent naphtha, etc., produced. Ultimately the company plans to have its own by-product coke ovens.

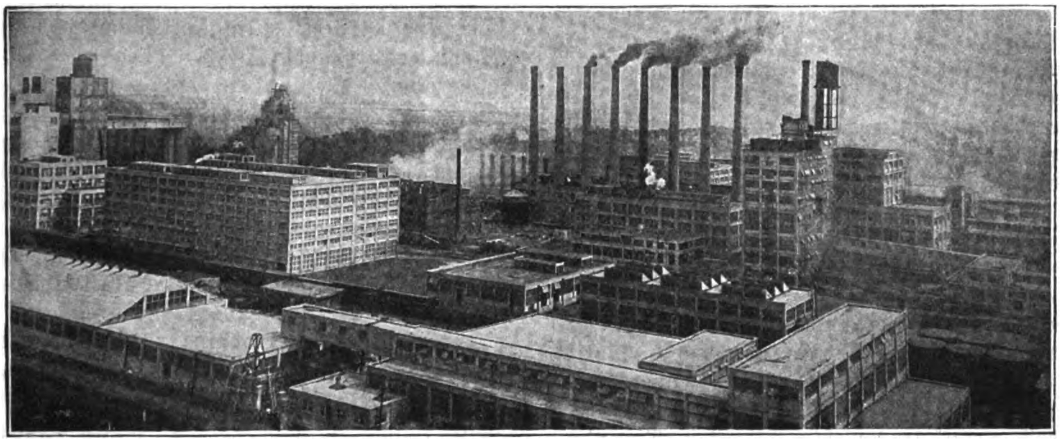
The Barrett Co. has a plant in Chicago for the refinery of coke-oven tar. Here it separates the pitch, light oil and heavy oil. Further refining of the light oil into benzol, etc., is taken care of at Eastern plants of the company.

Chicago has a number of rubber manufacturers. The Inland and the Century Rubber companies produce tires. The United States Rubber Co. (the Mechanical Rubber Co.) has a large plant producing belting, hose and molded soft rubber goods. The Dryden Rubber Co. produces molded goods and auto tubes and is contemplating engaging in the manufacture of tires.

The Essenkay Products Co. produces rubber substitutes—vulcanized oils—which are used in the rubber trade as well as for erasers, tire fillers, bath sponges, etc.

The field of dyestuffs is covered by three plants in Illinois in addition to the Lindsay Light Co., already mentioned. The Sherwin-Williams plant at Pullman is producing a great many of the dyes and intermediates formerly imported. Among the products are beta naphthol, mono-acid, Schaffer salt, R salt, G salt, Tobias acid, trisulphonic acid, acet-toluide, anthranilic acid, ponceau 5 R, lake orange B, lake red D, lake red C, scarlet 3 R, scarlet 2 RR, naphthol yellow S, pigment scarlet 3 B, orange GG, alizarine yellow GB, alizarine yellow G, alizarine yellow RW, alizarine brown 3 R, alizarine brown B, crocein scarlet, orange Y, brilliant orange 4 GR, scarlet 2 RG, fast red TEX, fast red A, fast red 3 BX, fast red 6 BX, lake red P pulp, litho fast orange O, graphic red R pulp, graphic red Y pulp, brilliant crimson No. 10, chrome black B, chrome black JB, acid claret B, fast acid milling black, methyl violet, paraphenylenediamine, ursol DB, ursol P, leather brown, fuchsine X, XX, XXX, XXXX, fuchsine crystals, alkali blue, spirit blue, soluble blue. It has also an acetic acid plant.

The Monroe Color & Chemical Co. at Quincy was forced into dyestuff manufacture to keep up a flourishing package dye business which had been built up on imported material. It is now making H acid, benzidine, dinitrobenzene, metaphenylene, diamine, benzo blue BB, navy blue, diamine green, brigot green, benzo orange, benzo purpurine and Monroe direct black, and



PLANT OF THE CORN PRODUCTS REFINING CO.

is able to supply its own needs and have a surplus for sale.

Dicks, David & Heller, at Chicago Heights, have been manufacturing since July, 1917, starting with fuchsine. They are now making fuchsine crystals, alkali blue, soluble blue, water blue, phosphine, malachite green and metinol yellow and are having success in foreign markets formerly filled with German products.

The Special Chemicals Co., Highland Park, was organized to produce certain unusual chemicals practically unobtainable in this country since the war. Among its products are a number of the rare bacteriological sugars and their alcohols such as inulin, glactose, levulose, xylose, dulcite and mannite. The company maintains a research department and expects constantly to add to the list of sugars now available. It also manufactures such chemicals as dimethylglyoxime, nitroso-beta-naphthol, cupferron, potassium cyanate and chemically pure uric acid. The raw material for this last named product was formerly sent from this country to Germany, manufactured there into pure uric acid, and subsequently resold in this country. It is just this condition of affairs that Special Chemicals Co. hopes to help correct.

Several firms whose main line is far from chemical have gone into chemical manufacture to fill special needs.

Sears, Roebuck & Co. have a paper mill with a capacity of 17 tons per day. Its waste paper furnishes the raw material for the production of paper suitable for wall paper. Mineral pigments are made, and organic lakes precipitated for wall paper colors.

The Western Electric Co., while not ordinarily considered in speaking of chemical manufacture, is conducting chemical operations of considerable magnitude and interest. This company has an extensive hard rubber department manufacturing rod, sheet, telephone receivers, etc.; a metal finishing division doing plating, sherardizing and Bower-Barff work; and a cable sheathing department producing about 40,000 tons of lead alloys per year. The production of ceramic insulation has been started and is likely to develop to considerable proportions. The most interesting development, however, is the refining of iron electrolytically. The plant for this purpose produces about seven tons per week. So far as known this is the only commercial plant in operation in the United States.

REFINERIES

Two refineries are located in the Chicago-Gary district, that of the Standard Oil Co. at Whiting and that of the Sinclair Refining Co. at East Chicago. The Whiting plant has a capacity of 35,000 bbl. of crude petroleum per day and the East Chicago plant of 6500 bbl. The crude petroleum is pumped direct from the Mid-continent field through two pipe lines that enter Illinois just north of Keokuk, Ia., and lead directly to these two refineries. The usual great variety of refinery products originate here, and the plants are interesting rather on account of the scale of their operation than because of unusual methods and equipment.

CLAY PRODUCTS

In the 24 ceramic plants in Cook County, Illinois, and the one in Lake County, Indiana—the two counties in which the Chicago-Gary district is included—well over $5,000,000 worth of brick and tile products and about $200,000 worth of pottery products, making in all a total of more than $5,500,000 for the ceramic industries, are manufactured. Common brick makes up somewhat more than half of the total value and architectural terra cotta, fireproofing, drain tile, floor tile, red earthen ware and sanitary ware are among the many other varieties of clay products manufactured in this district.

The North Western Terra Cotta Co. has the only terra cotta plant in the district. Ordinary clays from Indiana and crucible clays from all over the United States go into their 25,000 tons of terra cotta and the 100,000 high-grade smelting crucibles produced annually.

The Harbison-Walker Refractories Co. of East Chicago is equipped to make 100,000 silica brick daily. Its raw silica is quartzite from the Devils Lake (Baraboo) district of Wisconsin.

The abundance of ordinary raw clays in the surrounding district, the ease with which fuel and special raw materials are obtainable, and the large and growing market afforded by the industries and large population make of Chicago and its vicinity an admirable location for ceramic industries.

STONE, SAND AND GRAVEL

About $2,000,000 represented the value of stone produced in Chicago and immediate vicinity for 1917 and about one-third of a million dollars was the value of the sand and gravel.

Just about one-half the stone was used for concrete and about one-tenth for flux. Rubble, riprap, road making, railroad ballast, flux and fertilizers make up the uses of the remainder. Practically the whole of the million tons of sand and gravel produced in 1917 went into construction work.

One of the largest quarries for crushed stone in the Chicago district is that of the United States Crushed Stone Co. at McCook, about one mile west of Summit. Unusual features in machinery, equipment and methods of production make this plant of exceptional interest to other producers everywhere and to consumers of crushed rock.

SUMMARY

It is hoped that the reader will get some idea of the number and magnitude of the problems of chemical industry that are being solved in this region. Great as the development has been, it is only a beginning. Unequalled transportation facilities, a plentiful supply of fuel, space for development without a limit and a wonderful agricultural region to feed industrial populations are economic forces that are all working in favor of this district.

A dependable estimate of the total value of the industries in the Chicago-Gary district would be exceedingly difficult if not impossible to make. However, statistics are available which go to show that in Lake County, Indiana, and Cook County, Illinois, the value of the stone, lime, sand and gravel, clay products, mineral paint, pigments, cement, coke and steel reached easily the $300,000,000 mark in 1917. If statistics for the inorganic chemicals, the refinery products, the metallic products outside of steel and a number of smaller industries that could be classed as mineral were included, who knows but the estimate would be double?

Iron and Steel Plants Near Chicago

BY ERNEST EDGAR THUM

GARY comes first to mind when thinking of ferrous metallurgical plants near Chicago, but it should not be forgotten that many years before Gary was planned a very large and modern plant was operated at South Chicago by the Illinois Steel Co. Perhaps it was a knowledge of the operating cost and technical results attained at South Chicago which impelled the big men of the Steel Corporation to locate the huge Indiana Steel Co. and its affiliated operations a few miles southeasterly on Lake Michigan. Half way between point of origin of Pennsylvania coal and Lake Superior iron ores, closely adjacent to tremendous bituminous fields in the North Central States, with ample fluxes and refractories close at hand, with a large industrial center near by to use as a labor reservoir, in the center of wide agricultural districts to be used as a food store, served by unexampled railroad facilities and by water transport second only to a highly developed ocean port, this situation is well nigh ideal for large-scale operations in steel.

The South Chicago works of the Illinois Steel Co. are somewhat congested and lack orderly arrangement owing to the fact that the company started many years ago and built its plant as the demand for its products increased. However, the concern is officered by men of most progressive ideas, and its metallurgical practice has always been of the best—witness the fact that its was the pioneer in the production of electric steels in quantity, and has recently developed the triplex process—converter to open-hearth to electric—to a large-tonnage commercial success.

The company's plants at Chicago, Joliet and Milwaukee include 17 blast-furnaces, 8 converters, 35 open-hearth, and 3 electric furnaces. Its pig iron is largely consumed in its own steel making operations, whose ingots are rolled in 26 rail, merchant, bar and structural mills, eventually finding a market as rails, sheets and shapes. Its rail mills are especially noteworthy, being equipped with every possible labor-saving device —indeed, the rolling of the heavy rails required by American roads would be utterly impossible without most adequate mechanical handling equipment.

MECHANICAL HANDLING OF ORE AT GARY

Mechanical handling, especially of incoming ore, is utilized to the fullest extent at Gary. The methods are indeed not unique; but well repay study by one not familiar with modern methods in getting a heavy raw material like iron ore from a huge lake steamer into bin or stockpile. From the time the iron enters the plant as ore until it leaves as shape or billet, it is treated by mechanical and metallurgical equipment installed on a grand scale. The engineers who planned the Gary works were indeed fortunate in being able to start from the ground up, in having almost unlimited money at their command, and the best technical talent as associates. In this way they were able to plan not a series of departments but a huge machine, each part so designed to fit into its neighbor with the smoothest mesh and least lost motion.

Statistics of this largest of steel plants are more or less dry reading. Twelve blast-furnaces, 46 open-hearth steel furnaces, 14 blooming, rail, plate and merchant mills, a 560-retort coke plant and a list of the auxiliary departments would not give any comprehension of the magnitude of their operations.

Near by are associated a large number of steel-using manufacturing establishments, such as the closely affiliated American Bridge Co. While structural fabrication is somewhat foreign to metallurgy, still this company's excellent forge and annealing equipment will be of interest to those not attracted by the systematic way a large column or girder is assembled from a score of miscellaneous pieces. Seven high-speed steam-hydraulic presses are used in forging bent pieces, ranging in capacity from 150 to 3000 tons, the latter capable of turning out solid or hollow forgings weighing up to 50 tons. Twelve annealing furnaces of modern design make up the equipment in this department.

OTHER STEEL COMPANIES

At Indiana Harbor, the Inland Steel Co. has two modern blast-furnaces in operation, one of which is interesting in that it ran 5 years on its last lining, producing approximately 1,000,000 tons of pig. Molten iron is delivered to twelve 60-ton basic open-hearth furnaces, and the resulting steel ingots are rolled in a 36-in. blooming mill and a variety of smaller mills to a number of different shapes. Production at this plant approximates 1,000,000 tons of steel per annum, exclusive of the tonnage of small sections which have been produced at its Chicago Heights works since 1893.

In this same vicinity (South Chicago) the International Harvester Co. operates 3 blast-furnaces, with a yearly production of 450,000 tons of pig iron, a bessemer converter and a 35-in. blooming mill, 3 merchant bar mills and a shafting mill with a combined output of 350,000 tons of finished shapes.

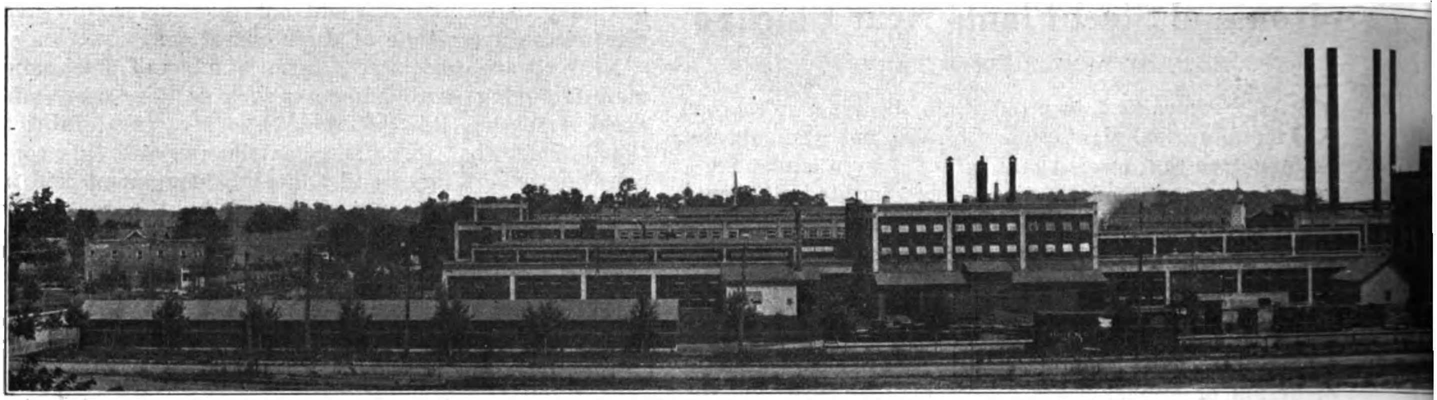
The Mark plant of the Steel & Tube Co. of America, at East Chicago, has only one blast-furnace, capacity 600 tons, but this is the largest in the country, being 15 per cent greater than any other. Steel is produced in open-hearth furnaces and is principally made into plates. The 30-in. universal plate mill holds a record for rolling more than 17,000 tons of plates in a month. The main mill tables are designed to shear plates. The mill is served by four 4-door regenerative heating furnaces.

This completes the list of steel companies which produce iron direct from ore in blast-furnaces. Several other concerns in this vicinity operate open-hearth furnaces, using scrap, cold pig and ore as their iron-bearing materials, while others, such as the Republic Iron & Steel Co. at East Chicago, produces a very sizable tonnage of merchant shapes from fagoted scrap.

ALLOYS AND CASTINGS

Among several companies, each of which deserves special attention, not possible in such a brief résumé of the subject, may be mentioned the three plants of the Interstate Iron & Steel Co., at South Chicago, Grand Crossing and East Chicago, specializing in alloy steels; the Hubbard Steel Foundry Co., at East Chicago, notable for high quality steel castings; the American Steel Foundries Co., and Standard Forgings Co., at Indiana Harbor, with a combined monthly output of 13,000 tons of car and locomotive parts and axles.

The Crane Co. operates two bessemer converters and one electric furnace; it is the largest manufacturer of valve iron in the world and during the war handled 700 tons of iron and steel a day in its three Chicago plants.



Natural and Industrial Resources of Indiana

A Description of Some of the Mineral Resources and a Review of Some of the Chemical Industries of Indiana—Importance of the State's Organic Chemical Plants and of the Work in Their Research Laboratories

Raw Materal Resources of Indiana

By W. N. Logan, Ph.D.
State Geologist

FROM a commercial standpoint the ideal State would be the one whose resources permitted it to supply its own needs. But it is a fact well established that no State lives to itself alone. But if during a world cataclysm such as we are experiencing an impenetrable barrier should be built about Indiana, the diversity of her natural resources and her manufacturing industries would enable her inhabitants to go forward toward the goal of self-preservation and self-realization. For Indiana has been favored with natural resources the variety, value and abundance of which are not realized by a large part even of her own citizens. In case of extreme isolation, Indiana could produce for her own needs enough coal, petroleum and its products, gas, iron, building stone, lime, cement, salt, fertilizers except phosphate, paint pigments, mineral dyes and by an expensive process aluminum. She would be without copper, nickel, lead, zinc, silver and platinum, though she could probably produce enough gold for front teeth filling.

The advance made in the utilization of some of these resources has been rapid, yet after more than a century of existence as a State many of its mineral resources remain latent or only meagerly developed.

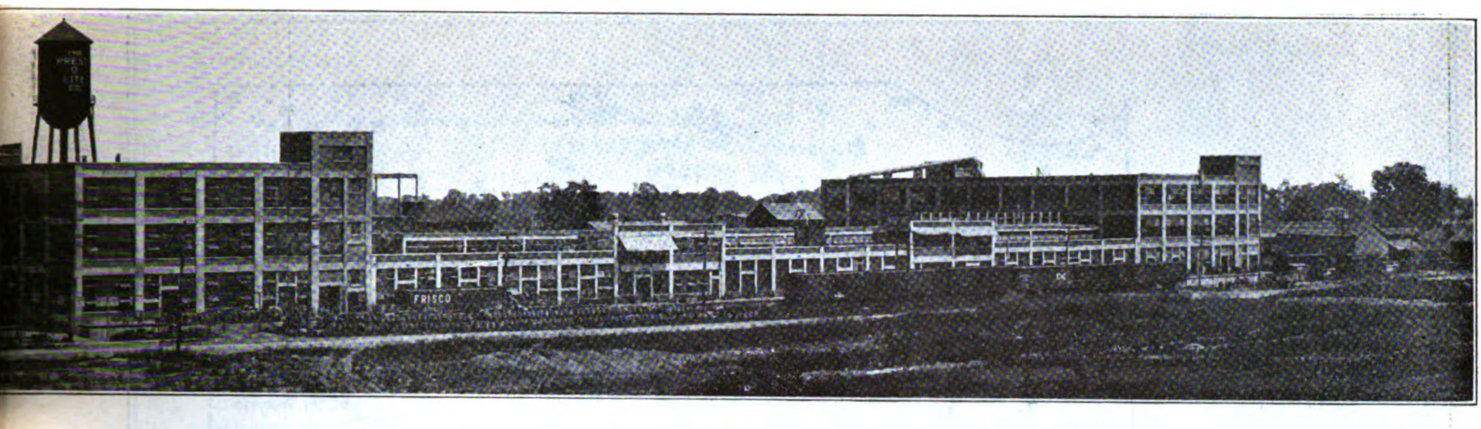
Fuel

Because of the dependence of manufacturing and industrial development on fuel, this resource is of primary importance, and Indiana's possessions in coal, petroleum and natural gas place her in a position of great economic independence. Of coal, Indiana produces annually its five tons per capita, the per capita consumption of the United States, and a surplus of nearly two and one-half million tons. The coal beds of Indiana occupy an area of approximately 7000 sq.mi. in the western and southwestern parts of the State. One or more beds underlie the whole of sixteen counties and parts of ten others. According to Ashley the total amount of coal in Indiana approximates 50 billion tons. Of this amount more than 13 billion tons is workable. The total amount which has been mined is about one-half billion tons. Approximately 17⅓ million tons are being mined each year, with a yearly increase between ⅓ and ½ million tons. The coals of Indiana rank well among the bituminous coals of the Interior basin. They contain a high moisture and volatile matter content and only a medium ash and sulphur content. Although belonging to the bituminous division, they contain a variety of high fuel value for domestic use called "block" coal because its laminated and jointed condition causes it to break up into large blocks; also a variety of cannel coal, which is a good gas producer. There are more than thirty beds of coal, nine of which are workable. The average thickness of the vein known as No. 5 is about 5 ft., and a maximum thickness of more than 10 ft. has been recorded. Indiana ranks sixth in the production of bituminous coal. One of its mines holds the world's record for the production of bituminous coal from one mine in a single day. The American mine located at Bicknell, Knox county, on Feb. 8, 1919, mined and loaded 6128 tons on 128 railroad cars in 8 hours.

Petroleum

A large amount of the petroleum produced in Indiana has come from the Indiana portion of what is known as the Lima-Indiana oil field. This includes, in Indiana, portions of Grant, Blackford, Huntington, Wells, Adams, Jay, Delaware, Madison and Randolph counties.

This field reached its highest production in 1904, when over 11 million barrels were produced in the State, the larger part from this field. The annual production for the State is still in excess of one and one-third million barrels. The southwestern Indiana field, extending from Martin county through Daviess, Pike and Gibson counties, is becoming an important field and will probably be extended. Sullivan county contains an area which is producing both oil and gas. The oil in the Lima field is obtained from the Trenton limestone. In the northern and southern parts of the State some oil is obtained from the Corniferous and in the southwest-



ern portion from the Mississippian and the Pennsylvanian formations. Wells are being drilled on untried territory in Martin, Monroe, Lawrence, Jackson, Jennings and other counties. Much untried territory lies in the State, but it is possible to determine the structural conditions only in the non-glaciated region.

NATURAL GAS

The largest natural gas area in Indiana lies in the eastern portion of the State, in the counties of Delaware, Blackford, Jay, Madison, Hancock, Henry and Randolph. Gas has recently been obtained from wells in Lawrence county and in the southwestern oil field in Pike and Gibson counties. The eastern gas field of Indiana reached the peak of production in 1902, when the value of the gas produced was more than 7 million dollars. At the present time the value of its production is somewhat under one million dollars. Much untried territory exists in the State and lends encouragement to the hope that production may again soon be on the increase.

The largest amount of gas has been found in the Trenton sands. Some has been obtained from the Corniferous, some from the Mississippian and some from the Pennsylvanian rocks.

PEAT

Many of the shallow lakes, marshes and ponds which were left on the surface of northern Indiana following the retreat of the glacial invasion were later filled with an accumulation of vegetable matter. This vegetable matter was gradually transformed into peat, the so-called first stage in the formation of coal. The workable peat beds cover approximately 36,000 acres and contain nearly 3 billion cu.ft. Enormous fuel values are represented in this resource, as well as mull, which may be used as an absorbent, packing material, deodorizer, fertilizer filler, in the manufacture of gas, coke and ammonia.

CEMENT

Indiana ranks second among the States in the production of cement, producing more than three times as much as it consumes, though it consumes annually more than one barrel per capita. Portland cement is the principal kind produced, but a small amount of natural cement is manufactured. There are five active plants, located at Buffington, Stroh, Syracuse, Speed and Mitchell, and one under construction at Limedale. The materials used are surface clays, marl from the lakes, slag from the iron smelters, hydraulic limestone from the Devonian formation and shale and limestone from the Mississippian formation. With the present capacity, under normal conditions the production of cement in Indiana would exceed 10 million barrels.

BUILDING STONE

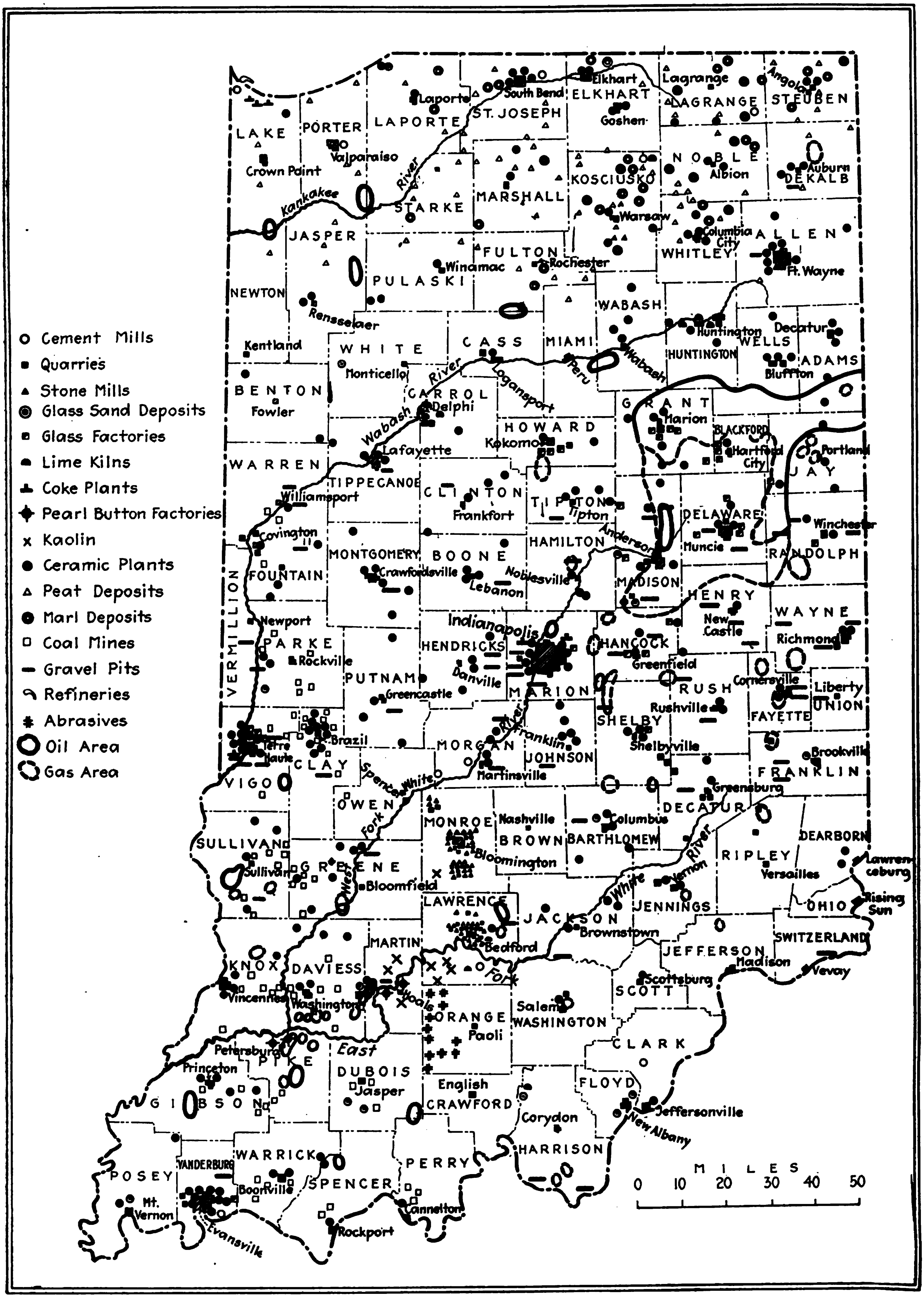
Indiana has attained an enviable position among the States of the Union as a producer of high-grade building stone. The oölitic limestone from the Salem formation, which is known as Indiana, Bedford or oölitic limestone, is highly praised by architects and builders and is widely used in the erection of both public and private buildings. Its uniform gray color, fineness of grain, freedom from planes of weakness, ease of carving, strength and durability recommend it to the builder. The best grades contain from 98 to 99 per cent of calcium carbonate and possess a crushing strength of 7000 lb. per sq.in. Two of the counties, Lawrence and Monroe, contain 36 large quarries which produce more than 70 per cent of all of the limestone used in the United States for building purposes. Fifty-five large mills prepare the stone for the market, handling more than 10 million cu.ft. per year. A recent order received by these mills includes enough dressed stone to fill 700 cars. The value of the stone for this contract is a little under one million dollars and it all goes into a single building.

The Indiana oölitic limestone has been used in nearly every State in the Union. It has been used in at least five State Capitol buildings, Indiana, Illinois, Georgia, New Jersey and Mississippi. The area occupied by this stone extends from Putnam county to the Ohio River, and its outcrop varies in width from a few rods to 14 miles. Its maximum thickness is about 100 ft. The Niagara limestone is a bedded stone which is quarried extensively in Indiana and is used for flagging, curbing, foundations, ashlar, piers, abutments and other purposes.

CERAMICS

Indiana produces a variety of ceramic wares, common, front, vitrified, ornamental and fire brick, totaling in value about 350 million dollars annually. Drain tile, encaustic tile, fireproofing, terra cotta, sewer pipe and stove lining are other important products. Pottery products manufactured are red earthenware, stoneware, yellow and Rockinham ware, white ware, C. C. ware, white granite, semi-porcelain, sanitary ware and porcelain electrical ware.

Indiana ranks sixth in ceramic production. The materials used in this industry in Indiana are the Knobstone shales, the Chester shales, the shales of the Pennsylvanian formation, the under or fire clays, gla-


○ Cement Mills
■ Quarries
▲ Stone Mills
◉ Glass Sand Deposits
▣ Glass Factories
Lime Kilns
Coke Plants
Pearl Button Factories
× Kaolin
● Ceramic Plants
△ Peat Deposits
● Marl Deposits
□ Coal Mines
— Gravel Pits
Refineries
Abrasives
Oil Area
Gas Area
LAKE
Crown Point
PORTER
Valparaiso
LAPORTE
Laporte
ST. JOSEPH
South Bend
ELKHART
Elkhart
Goshen
LAGRANGE
Lagrange
STEUBEN
Angola
NOBLE
Albion
DEKALB
Auburn
Kankakee
River
STARKE
MARSHALL
KOSCIUSKO
Warsaw
JASPER
Rensselaer
NEWTON
PULASKI
Winamac
FULTON
Rochester
WHITLEY
Columbia City
ALLEN
Ft. Wayne
WABASH
HUNTINGTON
Huntington
WELLS
Decatur
ADAMS
Bluffton
Kentland
WHITE
Monticello
CASS
Logansport
MIAMI
Peru
Wabash
BENTON
Fowler
CARROL
Delphi
Wabash River
GRANT
Marion
BLACKFORD
Hartford City
JAY
Portland
HOWARD
Kokomo
WARREN
Williamsport
TIPPECANOE
Lafayette
CLINTON
Frankfort
TIPTON
Tipton
DELAWARE
Muncie
RANDOLPH
Winchester
Covington
FOUNTAIN
MONTGOMERY
Crawfordsville
BOONE
Lebanon
HAMILTON
Noblesville
Anderson
MADISON
HENRY
New Castle
WAYNE
Richmond
VERMILLION
Newport
PARKE
Rockville
PUTNAM
Greencastle
HENDRICKS
Danville
Indianapolis
MARION
HANCOCK
Greenfield
RUSH
Rushville
FAYETTE
Connersville
UNION
Liberty
Terre Haute
Brazil
VIGO
CLAY
MORGAN
Martinsville
JOHNSON
Franklin
SHELBY
Shelbyville
FRANKLIN
Brookville
Greensburg
DECATUR
Spencer
White
Fork
OWEN
MONROE
Bloomington
BROWN
Nashville
BARTHOLOMEW
Columbus
SULLIVAN
Sullivan
GREENE
Bloomfield
West
RIPLEY
Versailles
DEARBORN
Lawrenceburg
OHIO
Rising Sun
LAWRENCE
Bedford
JACKSON
Brownstown
White River
Vernon
JENNINGS
SWITZERLAND
Vevay
JEFFERSON
Madison
KNOX
Vincennes
DAVIESS
Washington
MARTIN
Shoals
Fork
ORANGE
Paoli
WASHINGTON
Salem
SCOTT
Scottsburg
CLARK
Petersburg
Princeton
PIKE
East
DUBOIS
Jasper
GIBSON
English
CRAWFORD
Corydon
FLOYD
New Albany
Jeffersonville
HARRISON
POSEY
Mt. Vernon
VANDERBURG
Evansville
WARRICK
Boonville
SPENCER
Rockport
PERRY
Cannelton
MILES
0 10 20 30 40 50

MAP SHOWING DISTRIBUTION OF ECONOMIC PRODUCTS AND INDUSTRIES OF INDIANA cial till and kaolin. The Chester shales are used only to a limited extent, but their quality warrants a much more extensive utilization. The Pennsylvanian shales are used at Terre Haute in the manufacture of hollow block building tile, radial chimney blocks, partition tile, flue linings, drain tile, roof tile and paving brick and for many other purposes.

At Brazil the clay plants use fire clay from under the coal in the manufacture of front brick, sewer pipe, conduits, silo blocks, interlocking glaze tile and hollow blocks.

Some glacial till and shale are also used. The Knobstone shales are used at Martinsville, Brooklyn and other places. Surface clay and glacial till are used in the northern part of the State in the manufacture of drain tile and some other products.

LIME

Both quick and hydrated lime are manufactured in Indiana.

The limestones used for the manufacture of lime include the Niagara, the Mitchell and the Salem. There are other limestones, such as some of the limestones of the Chester group, which are suitable and have been used locally for lime. There are also deposits of marl which could be used for this purpose. The lime produced in Indiana is used in a number of industries, for building lime, glass manufacture, chemical lime, paper manufacture, sugar refining, tanning and agriculture. The production exceeds 100,000 tons per year. A portion is magnesian lime and a portion high calcium lime.

The Niagara limestone contains from 50 to 53 per cent of calcium carbonate and from 7 to 45 per cent of magnesium carbonate. The average of 5 samples contained 66.12 per cent of calcium carbonate and 26.38 per cent of magnesium carbonate.

The Salem or oölitic limestone contains for an average of five samples 98.11 per cent of calcium carbonate and 0.84 per cent of magnesium carbonate. The Mitchell limestone contains for an average of five samples 98.06 per cent of calcium carbonate and 0.45 per cent of magnesium carbonate.

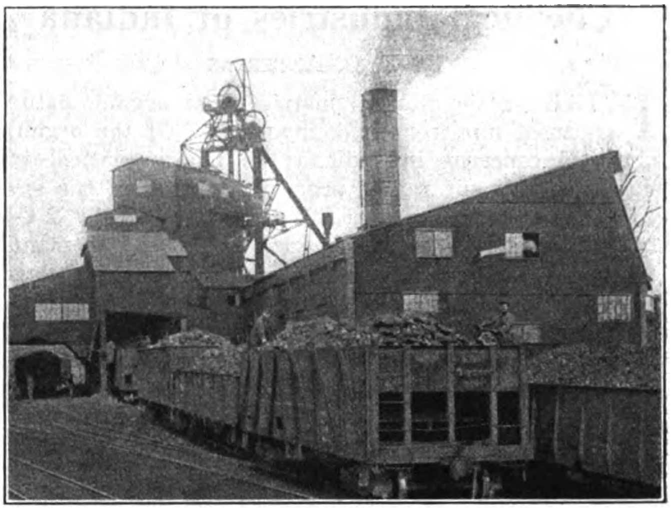
GRAVEL AND SAND

The invasion of ice during the glacial period left in its wake in Indiana not alone destroyed or reversed drainages but large quantities of sand and gravel which have been of great value to the State. Building sand, ballast sand, foundry sand, glass sand, paving and other sands are well distributed and the production is more than 3½ million tons a year. The annual production of gravel exceeds 2½ million tons, the greater part of which is obtained from the glacial deposits. In the unglaciated region some gravel is obtained from the Mansfield grit and from residual chert gravels produced by the weathering of the bedrock formations. Many of the streams which cross the non-glaciated area have their valleys filled with sand and gravel carried from the glaciated area.

This valley filling amounts in places to more than one hundred feet.

MARL

A secretion of white calcium carbonate, secreted largely by the plant Chara, accumulates on the floors of the lakes in Indiana and forms, with a slight mixture of clay and fine sand, beds of marl. The area extent of the available marl beds of Indiana is approximately 7500 acres containing approximately 137,133,333 cubic yards.



A COAL MINE WHICH PRODUCED 128 CARS, 6128 TONS, OF COAL IN 8 HR.—THE AMERICAN MINE AT BICKNELL, KNOX COUNTY, INDIANA

The marls of Indiana furnish the calcium carbonate used in the manufacture of portland cement. They are suitable for the manufacture of quicklime, agricultural lime and other purposes.

KAOLIN

A variety of halloysite called "Indianaite" occurs in more than half a dozen counties. The most important deposits are found in Martin and Lawrence counties. The kaolin has been used in the manufacture of ceramic wares, alum cake and for other purposes. A part of the deposit consists of a pure crystalline variety, but a great deal of it is stained a mahogany red by iron oxide.

The white kaolin is suitable for use in the manufacture of paper, paint pigments, ultramarine, filters, absorbents and buffing powders. The kaolin occurs at several horizons in the Mississippian formation and at the contact between the Mississippian and the Pennsylvanian formations.

MINERAL WATERS

There are many important mineral springs in Indiana. About 20 of them sell about $500,000 worth of water per year.

At seven of the springs there are hotel accommodations for more than 2500 persons. Much of the water is sold for medicinal use. Favorite watering places are French Lick, West Baden, Trinity Springs and Martinsville.

OTHER RESOURCES

A fine grade of oil stones is produced from the sandstones of the Chester and the Mansfield groups. A factory for the manufacture of oil stones is located in the northern part of Orange county. Potash has been manufactured from shale in Clark county, but production is still in the experimental stage. Pyrite from which sulphur is obtained is a by-product of the mining of coal and may be obtained from shales. Paint pigments occur in limited quantities. A little gold and some precious stones have been obtained from the glacial drift in a few counties.

Chemical Industries of Indiana

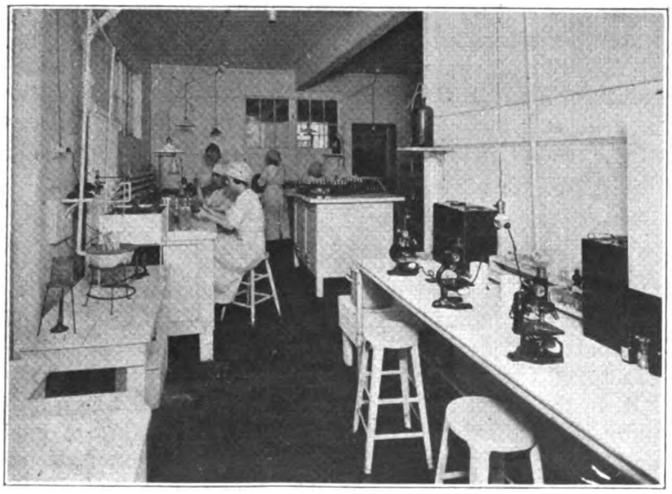
BY F. O. ANDEREGG

IN THE Hoosier State industries of an organic nature are most numerous and important. Of the organic chemical concerns in Indiana the pharmaceutical industry stands out rather prominently, and of the several companies engaged in this industry Eli Lilly & Co. of Indianapolis does the biggest business. It manufactures a complete line of pharmaceutical products and several alkaloids such as emetine, colchicine, hydrastine, cephæline, sanguinarine, etc. It has made nearly all the atropine sulphate used in this country and in England during the war from jimson weed by a process of its own. This company also has a large biological department where a great variety of serums and antitoxins are made and distributed.

Eli Lilly & Co. has long appreciated the benefits to be derived from a research department and has equipped a fine building for its use. The science building is provided with an excellent assembly room for use of salesmen's schools and meetings of employees; it is available also for the use of local scientific societies which from time to time are invited to be the guests of this firm. An excellent library devoted largely to chemistry, physiology, botany, experimental medicine and other lines cognate to pharmacy is maintained for the use of the scientific staff.

LILLY & CO.'S CHEMICAL LABORATORIES

The second floor of the building is occupied by admirably equipped chemical laboratories for analytical and research work. Each analyst has an alcove which is practically a complete chemical laboratory in itself. Additional apparatus like balances, polariscopes, spectroscopes, refractometers, etc., are in specially built rooms readily available for use. A well-equipped electrochemical laboratory is installed on this floor. On the third floor there is a department of experimental medicine where the drugs and chemicals which cannot be standardized chemically are tested physiologically upon selected lower animals. Investigations are conducted extending over long periods of time having for their purpose the determination of the deterioration and keeping qualities of various pharmaceutical products. Laboratory research work on synthetic drugs constitutes an important portion of the activity of the department of experimental medicine. The science building also provides quarters for an interesting laboratory for synthetical chemical research. With the installation of a noted expert in colloids this firm is preparing to carry on extensive research in the theoretical and practical development of this extremely important branch of chemistry.



BACTERIOLOGICAL LABORATORY, BIOLOGICAL DEPARTMENT, SWAN-MYERS CO., INDIANAPOLIS

CULTURE MEDIA LABORATORY, BIOLOGICAL DEPARTMENT, SWAN-MYERS CO., INDIANAPOLIS

As the inspection of crude vegetable drugs is a very important work in handling the enormous quantities of materials such as are necessary in manufacturing operations, the Lilly laboratories have maintained for the last 25 years an excellent botanical department which has quarters in the science building. The botanical laboratory proper contains large collections of authentic crude drug specimens, identified adulterations, substitutes, also standard herbarium specimens and an extensive collection of microscopic preparations of vegetable drugs. A conservatory is on the same floor for the purpose of propagating seedlings used in the study of medicinal plants and in work upon plant breeding. The botanical department, in addition to being charged with the inspection of crude drugs purchased for manufacturing, has also the supervision of extensive tracts of ground employed in raising drugs, and especially in experiments in drug plant breeding, with a view to improving the quantity of the medicinal principles.

OTHER LEADING CONCERNS

Another important concern also located in Indianapolis is the Swan-Myers Co. This firm manufactures a very complete line of pharmaceutical products which are used by the medical profession and by veterinaries. It also prepares a full line of biological products of a bacterial nature. The firm's products are sold throughout both Americas. The Pitman-Moore Co. is also located in the capital city and is engaged in the same sort of business, making a specialty of veterinary biological products. Other pharmaceutical concerns are the McCoy-Howe Pharmacal Co. of Indianapolis, the Lafayette Pharmacal Co. in the city of that name and the Central Pharmacal Co. of Seymour. Since the supply of chemicals from Germany has been cut off the Inland Alkaloid Co. of Tipton has perfected a number of processes for the manufacture of some of the mydriatic alkaloids. It has made notably large quantities of atropine sulphate from stramonium or jimson weed. Its products are sold only through wholesalers.

OTHER PRODUCTS KEEP FIRMS BUSY

The Mishawaka Woolen Manufacturing Co. is engaged in making woolen and rubber footwear and is solving some interesting chemical problems in making its goods wear longer and stand better the disintegrating effects of time.

Varnish and similar products are made by the well-known concern of South Bend, the O'Brien Varnish Co.

The Dodge Manufacturing Co. of Mishawaka has been engaged 100 per cent in war work. Besides manufacturing marine engines, gun carriages, conveyor systems for powder plants, it has been making aëroplane parts, using a waterproof adhesive developed in its own plant and used in the construction of plywood. This plywood was used on the wings and fuselages of aëroplanes by both the Army and Navy. There is reason to believe the NC boats were made complete with Dodge veneer. This development grew out of trunk manufacture.

There are several plants distributed throughout central Indiana for the manufacture of strawboard. There is usually a large demand for this product, and the supply is limited only by the amount of raw material available.

Starch, glucose and by-products are made by the Union Starch & Refining Co. of Edinburgh.

There are many concerns engaged in the canning business. The most prominent of these is the Van Camp Co. of Indianapolis, which is also most interested in chemical control and development work. A good example of the soft drink manufacture is the Centlivre Beverage Co. of Fort Wayne, which makes the well-advertised drink called "That's it."

This city is also the home of the Rub-No-More soaps.

One of the most interesting firms engaged in organic chemical industry has been the Commercial Solvents Co. of Terre Haute, which has been using a unique method for producing acetone by the fermentation of carbohydrates which yield ethyl alcohol as the most important by-product.[1]

The Prest-O-Lite Co. of Indianapolis is engaged in the manufacture of products of an organic as well as electrochemical nature. The name, Prest-O-Lite, has been associated with automobile service for many years. The use of acetylene for lighting and its wider application in oxy-acetylene welding are well known. The gas from the action of water on carbide is dissolved in acetone and stored in steel cylinders packed with a charcoal and asbestos filler. The cylinders are manufactured in sizes suited to various uses. The phenomenal growth of the Prest-O-Lite battery plant is indicative of the favor it has won with the public for automobile starting and lighting uses. During the past three years the plant floor space has increased nearly ten times. A proposed addition during 1920 will bring the total to 280,000 sq.ft. It is anticipated that the increase in facilities will enlarge the capacity to about 3500 batteries per day by the end of this year. The lighting and starting batteries are employed as standard equipment on 35 makes of motor cars and trucks. The elements consist or Faure type plates. In their manufacture lead oxide paste is applied to lead antimony grids. After a period of "setting" in dilute sulphuric acid, during which the oxide is largely changed to sulphate, the positive plates are converted to lead peroxide and the negative to lead sponge by electrolysis. The positive and negative groups are assembled with wood separators of maximum porosity, thus preventing the lessening of capacity at low temperatures, as happens when partially porous material such as perforated hard rubber is used.

About 20 years ago Indiana ranked second among glass-producing States. With the decrease in supply of natural gas this industry suffered, although with the introduction of labor-saving machinery during the last few years it has begun to advance again. Two important firms making glass are the Ball Bros. Glass Co. of Muncie, which makes a specialty of glass jars for household use, and the Fairmount Glass Works of Indianapolis, which makes a variety of glass bottles.

The United States Encaustic Tile Co. of Indianapolis makes some very beautiful decorative art mosaic, tiles and bricks.

CEMENT

Located at Mitchell in the southern part of the state are two 10-kiln plants of the Lehigh Cement Co. with a capacity of two and a quarter million barrels of cement a year. The raw materials are from the Mississippian formation and include the massive Mitchell series limestone and the Knobstone (or New Providence) shales. These rocks are made into a cement which is notable for its whiteness and is in special demand for sidewalks and curbing.

This Mitchell limestone is of a very high quality, running consistently better than 96 per cent pure calcium carbonate. It is made into high-grade chemical and hydrated lime by the Mitchell Lime Co. of Chicago. The purity of this material makes a very even slaking lime well adapted for a great variety of chemical reactions. In making the hydrated material exactly the right amount of water is scientifically added. Then the very finely divided hydroxide is separated from any grit by air separation and is packed in 50-lb. sacks, which are very carefully sealed, preventing appreciable deterioration. The company's products are used very successfully in the manufacture of soap, paper, rubber, varnish, insecticides, also in oil refining, the dehairing of hides, sanitation and water purification.

A very interesting alloy is made at Kokomo by the Ellwood-Haynes Stellite Co. It contains cobalt and chromium somewhat analagous to nichrome and seems to have many of the properties of that alloy in regard to its resistance to the action of most chemicals. But it has other unique properties, the most important of which is its extreme hardness. Stellite does not lose its characteristic hardness even at red heat, making it probably the best high-speed tool metal known. Its chemical and electrical properties are being tested in the laboratories of the Purdue University, and it offers promise of many useful applications in both of these industries.

A good example of the testing laboratories of the State is furnished by the Fort Wayne Testing Laboratory Co., which carries out a great variety of chemical and physical tests and plant control experiments involving metals, fuels, foods, cement, water, etc.

The chemical industries of the northwestern part of the State are not taken up in this article, since they belong with the Chicago district as described in an article elsewhere in this number.

---

[1] *J. Ind. Eng. Chem.*, 11, 723, gives an account of this process.

Natural and Industrial Resources of Michigan

General Review of the Mineral, Metallurgical and Chemical Industries — Leading Products Include: Iron, Copper, Salt, Alkalis, Halogens, Lime, Gypsum, Cement, Abrasives, Silica, Sugar, Paper, Dyes and Organic Chemicals

Mineral Resources of Michigan

BY R. A. SMITH

MICHIGAN is one of the foremost States in the production of minerals and mineral products. She produces about thirty different mineral products. The total value of these in 1917, exclusive of pig iron, was $185,511,101, and the value of pig iron shipped was $18,300,501. The production of copper amounted to 268,508,091 lb., valued at $75,622,256, and the shipments of iron ore amounted to 17,839,548 tons, valued at $60,508,942. The total value of copper and iron was $136,131,198, or nearly 74 per cent of the total value of the mineral products for the State.

The chief mineral products next in order of importance were salt, 16,078,136 bbl., valued at $6,877,202; portland cement, 4,688,899 bbl. shipped, valued at $6,122,887; coal, 1,374,805 tons shipped, valued at $4,426,314; limestone and lime sold $4,213,587; brick and tile products, $2,846,264; sand and gravel, $1,641,748; and gypsum, 375,803 tons mined and gypsum products sold, $1,568,655.

The other less important mineral products in order of value are silver, bromine, sand-lime brick, calcium chloride, mineral waters, grindstones and scythestones, potash, trap rock, glass-sand, quartz, clay, sandstone, petroleum, natural gas, marble, graphite, precious stones, mineral paints.

In 1917 Michigan held first rank in the production of salt, bromine, calcium chloride and sand-lime brick; second in iron ore and grindstones and scythestones; third in copper, gypsum and gypsum products; fourth in limestone and lime; sixth in sand and gravel, and eighth in portland cement.

The development of some of the mineral resources began early. The production of coal began as early as 1836, copper in 1845, iron ore in 1850, salt in 1859, and gypsum in 1860. The quarrying of limestone for burning lime began in Monroe county almost with the settlement of Detroit in 1701. The development of some of the other mineral products was comparatively recent —sand-lime brick about 1903, potash as a by-product of the portland cement industry in 1917, and marble in 1918. Michigan contains other mineral resources as yet undeveloped—feldspar, pyrite, slate, granite, celestite—and many of the other resources are susceptible of much greater development.

IRON ORE

The iron ores of Michigan are chiefly hematite, but there are some limonitic ores. The iron ore districts are located in the Northern Peninsula. The ore is produced in six districts, which in order of importance are: the Gogebic, Gogebic county; the Marquette, Marquette county; the Iron River, Iron county; the Menominee, Dickinson county; the Crystal Falls, Iron county, and the Gwinn, Marquette county. The total shipments of iron ore in 1917 amounted to 17,839,548 tons, of which the Gogebic Range contributed 7,003,838 tons, the Marquette 3,959,103 tons, the Iron River 2,525,741 tons, the Menominee 1,975,096 tons, the Crystal Falls 1,454,667 tons and the Gwinn 921,103 tons.

The total ore reserves Jan. 1, 1917, were estimated at 196,750,502 tons, of which 83,721,570 tons were developed ore, 107,954,081 tons prospective ore, and 5,132,343 tons ore in stock.

In 1916, 4,801,856 tons, or 25.4 per cent of the ore shipped, was of bessemer grade. The Gogebic Range contributed 3,933,594 tons, or 81.9 per cent, of the total bessemer ore produced, the Marquette Range (including the Gwinn District) 690,283 tons, or 14.4 per cent, and the Menominee 177,979 tons, or 3.7 per cent.

The average iron content of the ore as shipped was 53.03 per cent for the Gogebic, 52.43 per cent for the Marquette and 51.62 per cent for the Menominee Range.

COPPER

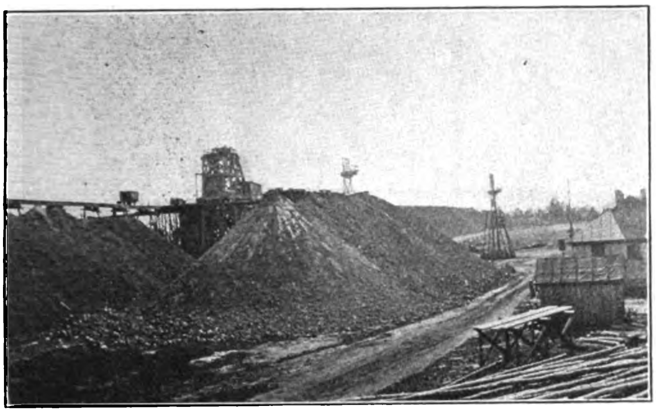
Prior to 1883 Michigan had produced 80.2 per cent of all the copper produced in the United States. In 1887 she was surpassed in production by Montana and in 1905 by Arizona. From 1845 to the close of 1917 Michigan produced 6,366,506,339 lb. of copper, or 25.27 per cent of the total production of copper of the country during this period.

The copper range extends from the northern extremity of Keweenaw Peninsula southwest through Keweenaw and Houghton counties into Ontonagon county. Copper-bearing rocks also occur on Isle Royale, in Lake Superior. The copper-bearing series comprise a thick succession of lava flows and interbedded sandstones and conglomerates. The copper deposits are unique in that they are the only large deposits in the United States in which the ore occurs chiefly as the native metal. The copper occurs in the cellular portions of the lava flows and in some of the beds of standstone and conglomerate and certain shales.

Most of the lodes are low grade. The average content of copper recovered from the ore treated in 1917 was less than 1 per cent. The copper values, however, are relatively uniform in the lodes. This, together with the high concentration possible with native ore and the low cost of refining, makes the mining of such low-grade deposits profitable.

SALT

The salt resources are inexhaustible and comprise natural brines and beds of rock salt. Natural brines occur in several rock formations. The brines from the Marshall sandstone have been utilized most extensively in salt manufacture in Saginaw Valley. Formerly this region was the center of the salt industry. It was carried on in connection with the lumber mills, but with the decline of lumbering it has become relatively unimportant. The Marshall brines contain considerable per-



IRON ORE AWAITING SHIPMENT AT PRINCETON MINE

centages of earthy chlorides and an appreciable content of bromine. These brines are the source of all of the bromine and calcium chloride produced in Michigan.

The chief salt-producing district is along Detroit and St. Clair rivers, but the Ludington-Manistee district is also an important producer. Salt is produced from artificial brines derived from underlying beds of rock salt. In the Detroit-St. Clair rivers district, the rock salt beds have an average aggregate thickness of over 400 ft. In the Ludington-Manistee district the aggregate thickness of the beds is less than 50 ft. More than 800 ft. of rock salt was penetrated in a well at Onaway and over 300 ft. at Grand Lake, Presque Isle county. Salt was also struck at Alpena, Alpena county. The salt resources of these counties, though unlimited, have not been utilized.

LIMESTONE

Michigan has very large deposits of limestone. Unfortunately most of the deposits are located in the northern part of the State relatively distant from large markets. Many of the deposits, especially in the Southern Peninsula, are on or near cheap water transportation, and this partially compensates for the distance from markets. Only a few important deposits of commercial limestone occur in the southern half of the State.

The principal limestone district of the Southern Peninsula extends across the northern end of the Peninsula from Thunder Bay to Little Traverse Bay. In the Northern Peninsula, the deposits form a belt from 10 to 15 miles wide extending from Menominee county on the west along the northern shores of Lake Michigan and Lake Huron to Drummond Island. There are numerous very large and many smaller exposures of limestone in both districts. The limestone varies in composition from nearly pure calcium carbonate to calcium-magnesium carbonate or normal dolomite. The deposits along the shore of Lake Huron in Presque Isle county are remarkable not only for their extent and thickness but for their very high average purity. The greater part of the limestone belt adjacent to the lake shores in the Northern Peninsula is characterized by high magnesian limestones or dolomites. Some beds are very pure, but others are very siliceous. The northern part of the belt contains several relatively thick high calcium beds of limestone interbedded with light to heavy magnesian limestone.

In the Southern Peninsula limestone is quarried on a large scale at Sibley, near Detroit; near Bayport, Huron county; at Alpena and Rockport, Alpena county; near Rogers, Presque Isle county, and along the south side of Little Traverse Bay. An important quarry is operated at Bellevue, Eaton county. In the Northern Peninsula large quarries are operated at Manistique and near Blaney, Schoolcraft county; at Hendricks and Fiborn and east of Trout Lake, Mackinac county.

The stone is used chiefly for flux, chemical purposes, commercial lime, portland cement, carbide, road metal, concrete aggregates, ballast, etc. A large tonnage of low-silica stone is produced at Rogers, Presque Isle county, for fluxing purposes.

MARL OR BOG LIME

Marl or bog lime occurs in hundreds of lakes and swamps in Michigan. The deposits vary in size up to several hundred acres and to 50 ft. or more in depth. Many deposits contain an average of more than 90 per cent of calcium carbonate, but others are very impure. Though only a small portion of the deposits have been investigated, the aggregate area of proved marl deposits is over 27,000 acres.

Most of the early cement companies in Michigan used marl, but, because of cheaper operating costs, they have since changed to limestone wherever possible. The use of marl for correcting sour or acid soils promises to become of considerable agricultural importance.

COAL

The coal basin underlies the central portion of the Southern Peninsula. In the early days of the coal industry producing areas were in the vicinity of Jackson, Jackson county; Owosso, Shiawassee county, and Grand Ledge, Eaton county. In 1897 the development of the coal deposits in Saginaw Valley began and now most of the coal is produced in Bay, Saginaw and Tuscola counties.

There are a number of coal beds, but most of them are too thin to mine under present conditions. The minable coal occurs in small basins or troughs varying from 100 to 2000 acres or more. The coal is a high volatile non-coking bituminous coal. It is an excellent domestic and a good steam coal.

GYPSUM

Large deposits of gypsum occur in the vicinity of Grand Rapids and Grandville, Kent county; in Iosco and Arenac counties, and in St. Ignace Peninsula and to the eastward on St. Martins Island, Mackinac county. Beds of gypsum apparently of commercial thickness and extent are also reported in Tuscola, Eaton and Ionia counties. The deposits are extensively developed in the Grand Rapids-Grandville district and at Alabaster, Iosco county. There are numerous beds in each district and several are of workable thickness. The largest beds are about 25 ft. thick. A portion of the crude gypsum is ground for land-plaster but most of it is calcined for stucco, mixed wall-plasters, plaster board, building block, calcimines and other gypsum products.

SAND AND GRAVEL

The sand and gravel deposits of Michigan are inexhaustible. The most important deposits occur in ridges known as "hogbacks" or eskers, in irregular hills called kames, and in outwash plains, deltas, and beach ridges—features resulting from water action during the last glacial invasion. Large deposits occur in nearly every locality. In the vicinity of industrial centers and along lines of rail and water transportation, the deposits have been extensively developed for general building purposes and concrete construction. Hundreds of gravel deposits have been developed for road building.

SILVER

Silver occurs in the deposits of native copper, chiefly as intergrowths of the two metals. The entire production of silver is derived from the copper ores.

BROMINE

The brines of the Marshall and Berea sandstones contain appreciable quantities of bromine. All of the bromine, however, is produced in Saginaw Valley from Marshall brines in connection with the salt and chemical industries. The chief centers are Midland, Saginaw and St. Charles. In 1917 Michigan produced 82.2 per cent of the bromine produced in the United States.

CALCIUM CHLORIDE

The Marshall brines, in addition to bromine, contain considerable percentages of calcium chloride. This is recovered as a by-product of the salt and chemical industries in Saginaw Valley. In 1917 this region produced nearly three-fourths of the calcium chloride produced in the United States. The chief centers are at Midland and Saginaw.

POTASH

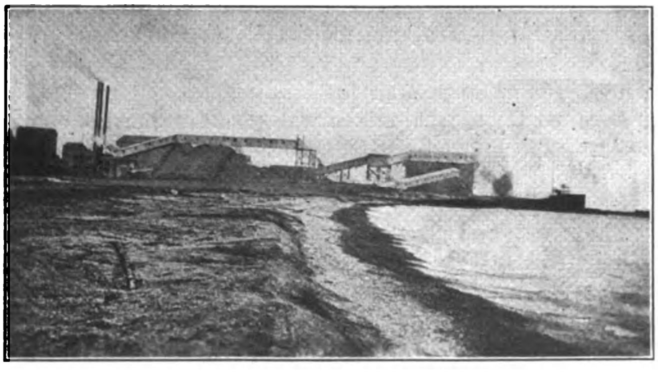
A considerable amount of potash is derived from leaching wood ashes, but in 1918 the production of potash as a by-product of the portland cement industry began at Newaygo, Newaygo county. There are large possibilities for a much greater production from the other portland cement plants which have not yet provided for the recovery of potash from escaping flue dust.

MINERAL AND SPRING WATERS

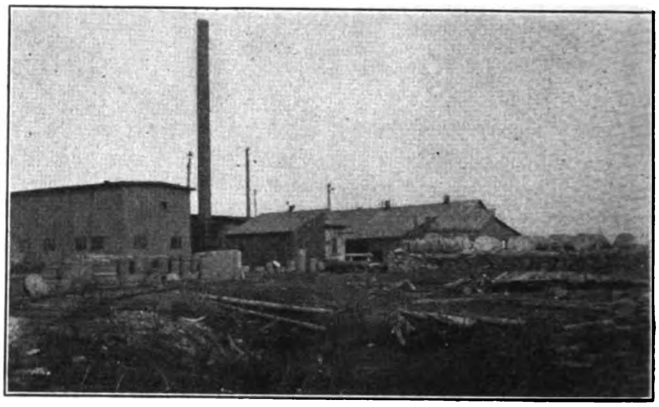
At Mt. Clemens, Ypsilanti and Detroit mineralized waters are produced in large quantities for bathing and medicinal purposes. Mineral and spring waters are also produced at a number of other places in the State. Some of the mineral waters are strongly mineralized and compare favorably with other famous mineral waters.

GRINDSTONES AND SCYTHESTONES

Grindstones and scythestones are produced in large quantities from certain beds of sandstone in Huron county. There are large deposits in the vicinity of Grindstone City and Port Austin.



CRUSHING PLANT AND STORAGE PILE OF THE MICHIGAN LIMESTONE & CHEMICAL CO. AT CALCITE



CLEVELAND STONE CO. WORKS AT GRINDSTONE CITY—SEAT OF GRINDSTONE AND SCYTHESTONE INDUSTRY IN MICHIGAN

TRAP ROCK

There are inexhaustible deposits of trap rock in the western part of the Northern Peninsula. Crushed trap rock for road metal and concrete aggregates is produced at Marquette and Negaunee, Marquette county. A large amount of trap rock is produced in connection with copper mining. The marketed production, however, is small because of the remoteness of the deposits from large markets.

GLASS-SAND

Large deposits of pure white silica sandstone occur in Wayne and Monroe counties. The sandstone is quarried, crushed and washed for glass-sand at Rockwood, Wayne county, and near Steiner, Monroe county. The sandstone is composed of pure silica sand with very little lime or other cementing material. The washed product from some beds contains over 99 per cent silica and only 0.001 per cent of iron. It is used chiefly for the manufacture of plate glass. Because of its exceptional purity it was used during the war by the U. S. Bureau of Standards for the manufacture of optical glass.

QUARTZ

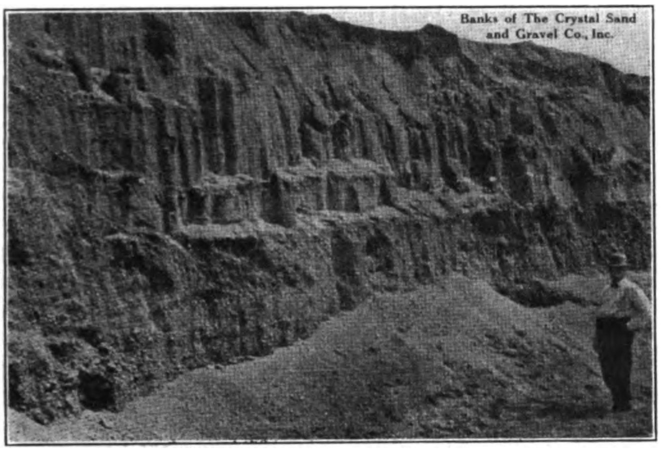
Pure white quartz occurs in large veins at many places in the western parts of the Northern Peninsula. It is quarried and ground near Ishpeming for wood filler, scouring polishes, etc. Analyses show that the quartz rock is practically pure silica.

CLAY

There are extensive deposits of surface clays, but most of them are high in lime and are suitable only for the manufacture of common brick and tile. In some of the deposits, leaching has removed the lime to considerable depths. Such deposits are adapted for the manufacture of higher grade products. In Ontonagon county some of the surface clays are of the slip variety and are utilized for glazing purposes. Surface clays are used at many places for the manufacture of common brick and tile. Most of the common brick are produced in the vicinity of Detroit.

SHALE

There are relatively few deposits of shale because most of the rock strata are concealed by the cover of glacial material. The only important deposits of shale in the southern part of the State are in Branch, Jackson, Eaton, Ingham, Genesee, Shiawassee and Sanilac



BANKS OF THE CRYSTAL SAND & GRAVEL CO., INC.

counties. There are numerous exposures of shale in Antrim, Charlevoix, Emmet, Cheboygan and Alpena counties, but these are distant from large markets. Shale also occurs in association with coal seams.

Shale is quarried near Coldwater and Union City, Branch county; near Ellsworth, Antrim county, and at Paxton, Alpena county, for use in the manufacture of portland cement, and at Jackson, Jackson county; near Flushing, Genesee county, and at Grand Ledge, Eaton county, for vitrified brick, tile and conduit. Deposits favorably situated in relation to markets and transportation occur at Williamston, Ingham county, and near Corunna, Shiawassee county. Shales associated with the coal beds in Saginaw Valley have been utilized for vitrified brick and tile products.

SANDSTONE

There are numerous exposures of sandstone in Hillsdale, Calhoun, Jackson, Ionia and Huron counties, in the Southern Peninsula. Most of this sandstone, because of its unstable color, is suitable only for rough building purposes. All of the numerous early quarries are now abandoned.

Unlimited deposits of mottled red and brown sandstone occur along the shores of Lake Superior in the Northern Peninsula. The stone has pleasing and permanent colors, but chiefly because of the great distance from markets the industry has declined until there is but one active quarry.

PETROLEUM

Petroleum has been struck in small quantities in numerous places in the State, but only at Port Huron has the quantity been sufficient for commercial development. The total output is insignificant.

NATURAL GAS

A small quantity of gas accompanies the oil produced at Port Huron. In several localities gas is found in small quantities in the glacial drift. The total production of natural gas is unimportant.

MARBLE

Numerous deposits of *verde antique* marble occur some miles northwest of Ishpeming, Marquette county. Production began in 1918. The marble is composed of serpentine and dolomite, the results of alteration of peridotite rocks. It displays an intricate system of veins and stringers of white dolomite in light to dark-green serpentine. It is massive in character and of excellent quality. The polished product compares very favorably with the best domestic and imported *verde antique.*

GRAPHITE

Graphite occurs in slates in Baraga county. The graphitic slate is quarried and ground for paint material. No attempt has been made to recover the graphite from the slate.

PRECIOUS STONES

Chlorastrolite, thompsonite, and some semi-precious stones are produced in small quantities in the copper-bearing region. Chlorastrolite is a beautiful mottled-green gem stone, peculiar to the Lake Superior copper-bearing district. The total value of the annual production of gem stones is very small.

MINERAL PAINTS

Certain of the iron ores in the Northern Peninsula are suitable for the manufacture of paint. Formerly several thousand tons of these ores were produced annually and sold for the manufacture of paint pigment.

SLATE

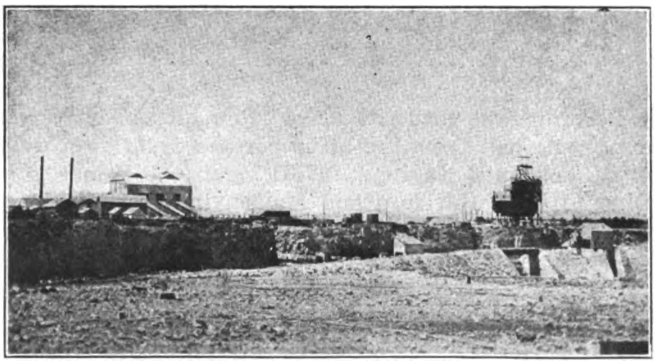
Extensive deposits of slate occur in Baraga county. The slate is very black, of fine texture and permanent in color. It appears to be of superior quality and suitable for roofing and other purposes for which slate is adapted. Prior to 1888 a number of slate quarries were operated for several years near Arvon, Baraga county. Apparently because of inefficient methods of quarrying, great distance from markets and lack of cheap transportation facilities the industry was unprofitable.

GRANITE

Extensive exposures of granite occur in many localties in the western part of the Northern Peninsula. Several unsuccessful attempts have been made to develop some of the deposits, but no production has been reported for many years.

PYRITE

Pyrite occurs in considerable abundance in some of the coal seams and associated rocks and also at certain horizons of the Antrim black shale. At some of the coal mines, the recovery of lump pyrite offers commercial possibilities. The most promising source of recovery is at the coal washery at Saginaw. Tests show that the refuse contains about 30 per cent of pyrite and that a concentrate containing considerably over 40 per



CRUSHING PLANTS OF THE MICHIGAN ALKALI CO. AT ALPENA

FALLS ON MENOMINEE RIVER ABOVE MANSFIELD

cent of sulphur is possible. Probably the pyritic waste from the different mines would be sufficient to supply a concentration plant.

CELESTITE

Celestite occurs as scattered masses in some of the limestone and glass-sand quarries in Wayne and Monroe counties. At Rockwood, Wayne county, the mineral occurs in masses of sufficient abundance to warrant recovery. No production of celestite, however, has been reported.

FELDSPAR

There are deposits of potash feldspar near Republic in sec. 22, T.47 N., R.29 W., Marquette county, and in sec. 8, T.46 N., R.41 W., Gogebic county. An unsuccessful attempt was made many years ago to develop the deposit near Republic. Probably further investigation in the Northern Peninsula would result in the discovery of other deposits of potash feldspar.

WATER POWER

Water power has been extensively developed on the St. Joseph, Kalamazoo, Grand, Muskegon, Manistee, Thunder Bay, Au Sable and Huron rivers in the Southern Peninsula and on the Menominee, Carp and St. Mary's rivers in the Northern Peninsula. Large powers have been developed on many of the other rivers in the State. There is an abundance of undeveloped water power on these streams, notably the Escanaba, Ontonagon and Taquamenon, and the water powers on the Muskegon, Manistee, Menominee and Au Sable rivers also are susceptible of much greater development.

Salt, Bromine and Calcium Chloride in 1918[1]

The production of salt (in short tons) in the United States during 1918 was as follows:

Grade	United States	Michigan
Manufactured (evaporated)......	2,724,203	1,059,872
In brine.........................	2,830,600	....
Rock salt.......................	1,683,941	....
Total	7,238,744	2,403,125

Bromine was made as usual from bittern left after extracting salt from the brine pumped from deep wells at Midland and Saginaw in Michigan; at Pomeroy in Ohio; Mason, Hartford and Malden in West Virginia; 1,727,156 lb. of bromine (either as the free element or its salts) was produced in 1918.

Calcium chloride, containing 2 to 6 per cent of magnesium, is recovered as a by-product in the manufacture of salt and bromine in the localities mentioned above. There was produced in 1918 26,624 tons.

---

[1] U. S. Geological Survey Bulletin, by Ralph W. Stone.

Chemical Industries of Michigan

By W. L. Badger

IN GENERAL, it would seem that in Michigan there is represented practically every important chemical industry, organic and inorganic. In many of the basic industries Michigan is either first or in the first two or three of all the States. Raw materials of all sorts are plentiful, the State is not far from the coal fields, and is almost midway between the great markets of the East and the mid-West. Among the many and various chemical and allied industries the following deserve to be specially mentioned:

SALT

The history of salt manufacture in Michigan goes back to 1838, when the State appropriated $3000 to bore for salt at one of the salt springs. This work was continued for several years, but never gave any results. The first private plant to make salt was at Grand Rapids in 1840, but its life was short. In 1859 the industry was revived, aided by a State bounty; and though the bounty was not continued long, the industry continued to thrive till in 1905 the State led all her sister States in quantity of salt produced, and in 1906 in value of product. This position it has kept ever since. An important feature in the growth of the salt industry was the utilization of waste steam from sawmills. To dispose of waste the sawmills built incinerators; and the next idea was to burn the waste under boilers and use the steam for salt making. Hence we find the largest number of salt companies and the largest total number of grainers in the period from 1880 to 1895. Since then the industry has gradually concentrated into the hands of fewer and fewer companies, which make salt as a primary product and not as a by-product as in the days of the lumber industry.

The most important source of salt in Michigan is the Salina formation of rock salt. In some districts the wells are in higher strata; and in the Saginaw Valley the brine comes from flowing wells. The Salina is, however, the largest and purest deposit. In many cases underground waters flow into the salt beds to yield the brine, but in the majority of cases the brine is artificially formed by pumping water down to the salt layer. Practically all plants in the State work on brines running from 95 to 100 per cent saturated; many never fall more than a few tenths of 1 per cent short of complete saturation. At one of the largest plants in the State, a few years ago the question came up of filtering the water fed to the wells in order to get a cleaner brine. From the records of the amount of salt produced the size of the cavity in the salt bed was estimated; and it was found that if the water spread out evenly over the surface of the cavity, and the brine was drawn evenly from the bottom of the cavity, it would take about three years for the filtered water to appear at the top of the well.

The beds are worked around Detroit and along the St. Clair River. South of Detroit the salt suddenly disappears; and to the north and east the beds rapidly get deeper. Around Detroit the Salina rock salt is at 1000 to 1500 ft. and is 100 to 400 ft. thick. Along the Lake Michigan side the salt reappears, so that the State has three well-marked salt districts—the Detroit district, the Saginaw district and the West district.

EARLY PROCESSES OF SALT MAKING

Only in the very early days was salt made in the kettle. The next development was the pan—some 20 to 30 ft. wide, 100 to 150 ft. long, and 12 to 18 in. deep. They were direct fired, and the salt was raked out by hand. Little or no salt is now made in this apparatus, though up to a short time ago old salt pans were still standing along the St. Clair River.

With the growth of the lumber industry came the grainer, a distinctly Michigan type of salt-making apparatus. This is a tank 18 to 24 in. deep, 12 to 18 ft. wide and 100 to 120 ft. long. In this are submerged a number of pipes through which passes steam (or hot condensed water from previous grainers). The brine does not boil, but merely evaporates slowly. The size of grain depends on the rate of evaporation, which in turn depends on the temperature of the brine, as the coils are heated by live steam, exhaust steam, or condensed water. The salt grows on the surface as floating aggregates of hopper-shaped crystals. These fall to the bottom and are raked out by hand, or more often by mechanical rakes actuated by hydraulic cylinders. The grainers are made of wood, steel or concrete.

In 1887 the first vacuum pan was introduced into Michigan, and there are now a number of plants using single or multiple effect vacuum pans. This process gives a fine, uniform, compact grain, very well suited for table purposes. The coarse and less compact grainer salt occludes mother-liquor and is less pure.

THE ALBERGER PROCESS OF SALT MAKING

Michigan has the only plant in this country using the Alberger process. In this process the brine is heated in steps to about 350 deg. F., at which point the solubility of calcium sulphate is very low. The brine is then led through cylinders filled with stones, where the gypsum is deposited, the supersaturated solution being seeded by crystals adhering to the stones; and then the brine is led to the "evaporators." These are nothing but cylinders with an opening near the top where the superheated brine is allowed to escape. The flash or self-evaporation which takes place when the pressure is relieved causes the formation of seed crystals. The hot brine with these seed crystals is blown out into large shallow pans. Surface evaporation causes the crystals to grow till they fall to the bottom and are raked to a well, whence they pass to a centrifuge. The brine overflowing from the pans is returned to the heaters. This process gives a very open and porous grain, but far finer than the grainer salt. It is almost entirely used for table and dairy purposes.

No account of the Michigan salt industry is complete without mention of the Manistee Iron Works. They introduced the vacuum pan into the salt industry; and Manistee pans are found not only in most of the vacuum pan plants of the State, but in many salt plants throughout the country.

Table I gives a list of some Michigan salt plants, and Table II gives the Michigan salt production as compared with that of the total in the United States for the years 1914 to 1917.

BROMINE AND CALCIUM CHLORIDE

The brines of the Saginaw Valley contain many impurities, chiefly bromides and calcium and magnesium salts. The Dow Chemical Co. of Midland has for years been by far the largest producer of bromine in the United States. The brine is electrolyzed to give a gas consisting of chlorine and bromine, and this gas is used to displace the bromine from the brine. Calcium chloride is made by the Saginaw Chemical Co. Bitterns discarded from salt grainers are further concentrated, which throws out much sodium chloride. The solubility of sodium chloride decreases rapidly as the concentration of calcium chloride increases. The remaining mixture of calcium and magnesium chlorides is concentrated till it solidifies when run into drums. Large quantities of calcium chloride are also obtained as a by-product in the Solvay process.

ALKALIS, ACIDS AND HEAVY CHEMICALS

Because of the salt deposits, Michigan has an enormous alkali industry. In the Detroit district are the Solvay Process Co., the Pennsylvania Salt Manufacturing Co. and the Michigan Alakali Co. The Dow Chemical Co. at Midland also produces alkali. The Solvay Process Co. and the Michigan Alakali Co. use the Solvay process; the others make electrolytic caustic. The Pennsylvania Salt Manufacturing Co. uses the Gibbs cell; the Dow Chemical Co. a cell of its own.

Sulphuric and nitric acids are made by the Detroit Chemical Works, which also makes alum. The electrolytic plants of course make either chlorine or bleach according to the demands; though the Dow Chemical

TABLE I—MICHIGAN SALT PLANTS *

Plant	Location	No. Wells	Grainers				Vacuum Pans			Other Processes	Daily Capacity, Bbls.
			No.	Material	How Sifted	Size	No.	Operation	Size		
Bliss & Van Auken Lumber Co.	Saginaw....	4	2	Wood	Rakes	170 x10 ft. x 22 in.	...	....	....	....	100
Buckley & Douglas Lumber Co.	Manistee...	4	15	Cement	Rakes	150x12 ft. x 22 in.	2	Single	11 ft.	....	2,200
Diamond Crystal Salt Co......	St. Clair....	5	6	Steel	Rakes	7 ft. 3 in. x 115 ft. x 18 in.	1	Single	6 ft.	Alberger	2,850
Eastman Salt Products Co......	Saginaw....	2	4	Wood	Hand	8x110 ft. x 18 in.	...	....	....	....	100
Filer & Sons..................	Filer City...	1	...	....	.....	....	1	Single	13 ft.	....	500
Germain, Edward............	Saginaw....	2	4	Wood	Hand	150x12 ft. x 22 in.	...	....	....	....	.....
Hine Lumber Co............	Bay City...	1	2	Wood	Hand	150x12 ft. x 18 in.	...	....	....	....	50
Inland-Delray Salt Co........	Delray.....	2	6	Steel	Rakes	160x16 ft.	3	Triple	9, 10, 11 ft.	....	2,000
Mershon-Eddy-Parker & Co...	Carrollton..	3	4	Wood	Hand	145x12 ft. x 18 in.	...	....	....	....	90
Mich. Salt Works............	Marine City	2	2	Cement	.....	164x18 ft. x 22 in.	...	....	....	....	.....
			2	Steel	.....	100x18 ft. x 6 ft.	...	....	....	....	.....
			1	Wood	.....	120x12 ft. x 22 in.	...	....	....	....	.....
			3	Cement	.....	120x12 ft. x 22 in.	...	....	....	....	800
Morton Salt Co.............	Ludington..	5	...	....	.....	....	3	Triple	18, 19, 20 ft.	....	2,000
Morton Salt Co.............	Pt. Huron..	8	9	....	.....	....	...	Triple	....	....	3,000
Saginaw Plate Glass Co.......	Saginaw....	10	14	Cement	Rakes	150x12 ft. x 18 in.	...	....	....	....	1,000
Saginaw Salt Co............	St. Charles	4	10	Wood	Hand	150x12 ft. x 30 in.	...	....	....	....	300
Louis Sands Salt & Lumber Co.	Manistee...	4	25	Cement	Rakes	150x12 ft. x 22 in.	...	....	....	....	1,600
Stearns Salt & Lumber Co......	Ludington	3	25	Wood	Rakes	150x12 ft. x 22 in.	1	Single	12 ft.	....	1,400
Peter Van Schaak & Sons......	....	...	...	....	.....	....	...	....	....	....	.....
Worcester Salt Co...........	Ecorse......	2	8	Steel	Rakes	140x12 ft. x 22 in.	3	Single, double or triple	10 ft.	....	2,500

* The above data are taken from "The Brine and Salt Deposits of Michigan," C. W. Cook; Mich. State Geological and Biological Survey, Publication 15, Geological Series 12, 1914. The list includes only plants described in the above Bulletin and mentioned as producing in "Mineral Resources of Michigan for 1916," Mich. State Geological and Biological Survey, Publication 24, Geological Series 20.

TABLE II—MICHIGAN SALT PRODUCTION

Year	Total Production of U. S., Bbls.	Michigan Production, per Cent. of Total	Total Michigan Production, Bbls.	Table and Dairy		Packers				Rock and All Others		Brine	
						Common Fine		Common Coarse					
				Bbls.	Value	Bbls.	Value	Bbls.	Value	Bbls.	Value	Bbls.	Value
1914	34,402,772	33.92	11,670,976	1,092,344	$1,025,164	2,668,989	$911,016	2,380,378	$870,715	712,530	$252,024	4,816,735	$240,086
1915	38,231,496	32.93	12,588,788	1,233,117	1,420,382	3,096,644	1,181,337	2,265,353	1,001,167	919,735	321,354	5,073,940	380,491
1916	45,449,382	32.82	14,918,278	1,305,950	1,461,085	3,109,857	1,221,901	2,133,600	1,064,709	1,012,942	368,022	7,365,927	506,850
1917	49,844,121	32.45	16,078,139	....	....	....	....	....	....	....	....	....	....

Co. uses most of its chlorine in various organic products.

The North American Chemical Co. at Saginaw makes electrolytic chlorate.

POTASH

Michigan's contribution to the potash situation has been from two sources—wood ashes and beet sugar waste waters. This latter is mentioned in connection with the sugar industry. In the hardwood districts there are reported about 25 small producers of potash salts from wood ashes. The ashes are packed in shallow tubs, leached, and the resulting solution concentrated till it solidifies. The product is mainly carbonate; if lime is added with the ashes it is largely hydroxide. Of some 32,500 tons of K_2O reported as produced in the United States in 1917, wood ashes (in which Michigan has 25 out of 49 producers) are credited with furnishing 621 tons, and beet sugar waste waters (where Michigan has one out of 5 producers) with 370 tons.

IRON AND STEEL

Though Michigan is the second largest producer of iron ore in the United States, the iron actually smelted is very small in amount. The Marquette, Gogebic and Menominee ranges, lying mainly in Michigan, produce about 25 per cent of the country's total output of ore and about 30 per cent of the output of the Superior district. Michigan is only about seventh in pig iron production, having only 14 blast-furnaces. The State has no steel plants, though there are steel foundries having one or two open-hearth furnaces apiece. Most of the blast-furnaces are connected with the hardwood distillation industry, and serve as an outlet for the charcoal. Detroit has three furnaces—two at the plant of the Detroit Iron and Steel Co. and one at the plant of the Detroit Furnace Co.

Table III gives a list of the Michigan blast-furnaces operating in 1916.

TABLE III—BLAST-FURNACES OPERATING IN 1916.

Lake Superior Iron & Chemical Co.	1	Boyne City
Lake Superior Iron & Chemical Co.	1	Chocolay
Mitchell-Liggins Iron Co.	1	Cadillac
Detroit Furnace Co.	1	Detroit
Detroit Iron & Steel Co.	2	Detroit
East Jordan Furnace Co.	1	East Jordan
Cleveland Cliffs Iron Co.	1	Gladstone
Antrim Iron Co.	1	Antrim
Pioneer Iron Co.	2	Near Marquette
Stephenson Charcoal Iron Co.	1	Wells
Charcoal Iron Co. of America	1	Chocolay
Charcoal Iron Co. of America	1	Boyne City
Charcoal Iron Co. of America	1	Elk Rapids
Charcoal Iron Co. of America	1	Manistique
Charcoal Iron Co. of America	1	Newberry
New Metals Process Co.	1	Marquette

NON-FERROUS METALS

Michigan has for some time been the country's third largest producer of copper. Other than this no nonferrous metals are smelted in appreciable amounts. The State has some of the largest copper and brass mills in the country, including the Detroit Copper & Brass Rolling Mills, the Michigan Smelting & Refining Co., the Michigan Copper & Brass Rolling Mills.

COKE

The State possesses two coke oven plants, neither primarily connected with the iron industry. The ovens are at the plants of the Solvay Process Co. and the Michigan Alkali Co.; and both plants use the ovens as a source of ammonia. The coke goes to the blast-furnaces in Detroit, to the lime kilns of the alkali process, or is sold for domestic consumption.

The Solvay Process Co. obtains its ammonia from the Semet-Solvay Co., which operates 175 Semet-Solvay ovens. The latest bank of these are equipped to burn producer gas, as under a heating value specification so much gas can be sold to the city of Detroit that not enough remains to heat the ovens. All the newer ovens are regenerative, in contrast with the older design of the Semet-Solvay oven, which was recuperative.

The Michigan Alkali Co. has 30 United-Otto ovens.

COAL AND PEAT

A large area in the central part of the State contains coal. The deposits have been worked more or less since 1835, but the industry did not develop till 1897. Recently the production has been about 1,000,000 tons per year. The coal is bituminous, dry and non-coking, and generally of a lower grade than the Eastern coals with which it has to compete. In 1916 there were reported 22 mines.

The State has very extensive deposits of peat—in fact, over the whole State peat bogs are common. Numerous attempts have been made to work these deposits, and much good money has been wasted. Without exception the plants have all been failures. The peat remains, however, as a possible fuel when either coal is so high as to make it available, or satisfactory methods are found for its utilization.

BEET SUGAR

Michigan is almost the home of the beet sugar industry in the United States. Certainly the industry took hold here in a very healthy manner and mills were built more rapidly in Michigan than in any other State. As the value of irrigated lands and the favorable climate of the Western States began to be appreciated, Colorado and California passed Michigan, but Michigan still remains one of the principal producers of beet sugar. Table IV is taken from the U. S. Department of Agriculture Yearbook,' 1917.

The drop from third to fourth place in 1916 was due not only to the falling off in the Michigan production, but to the rapid rise of Utah as a beet sugar State.

The beet mills in the State are shown in Table V.

TABLE IV—BEET SUGAR INDUSTRY IN MICHIGAN

Year	Michigan's Rank	No. Factories	Campaign Days	Tons Sugar Made	Acres Harvested	Tons Beets per Acre	Tons Beets Worked	Price per Ton	Per Cent Sugar in Beets	Purity	Per Cent Sugar Recorded	Per Cent of Total Sugar Recovered	Per Cent Loss	Michigan Production per Cent of U. S. Total
1914	3	15	68	110,630	101,300	8.5	857,100	$5.23	15.78	82.85	12.91	81.81	2.87	15.3
1915	3	15	78	129,997	122,000	8.2	997,972	5.91	15.45	84.08	13.03	84.34	2.42	14.7
1916	4	15	49	69,341	99,619	5.05	502,705	6.14	16.37	85.22	13.79	84.24	2.58	8.4
1917	4	14	53	64,247	82,151	5.62	461,721	8.04	16.28	86.57	13.91	85.44	2.37	8.4

The figures are from the Department of Agriculture Bulletin No. 721.

TABLE V—BEET SUGAR PLANTS IN MICHIGAN

Company	Location	Erected	Tons Beets Worked in 24 Hours
Holland-St. Louis Sugar Co.	Holland	1899	500
Michigan Sugar Co.	Bay City	1899	1,400
Michigan Sugar Co.	Alma	1899	1,400
West Bay City Sugar Co.	West Bay City	1899	900
Michigan Sugar Co.	Caro	1899	1,200
Independent Sugar Co.	Marine City	1900	600
Columbia Sugar Co.	West Bay City	1901	1,500
Owosso Sugar Co.	Lansing	1901	600
Michigan Sugar Co.	Carrollton	1902	900
Mount Clemens Sugar Co.	Mount Clemens	1902	600
Michigan Sugar Co.	Croswell	1902	750
Michigan Sugar Co.	Sebewaing	1902	850
Holland-St. Louis Sugar Co.	St. Louis	1903	600
Menominee River Sugar Co.	Menominee	1903	1,200
Owosso Sugar Co.	Owosso	1903	1,200
Continental Sugar Co.	Blissfield	1905	868

This shows the State to have a total capacity of 15,000 tons of beets per day. With a campaign of 70 days this calls for a little over 1,000,000 tons of beets for the campaign. This means that the industry was working to capacity in 1915; but, with a campaign of 50 days, only about two-thirds capacity in 1916 and 1917.

Many mills run the Steffens process, and many dry their pulp for the manufacture of cattle feed. Since the mills are all older than most Western mills, the newer equipment (such as labor-saving filters, etc.) found so frequently in the Western mills has not yet been generally introduced.

Two interesting developments in connection with the sugar industry are the plants of the Michigan Chemical Co., at Bay City, which ferments beet molasses to alcohol; and the plant of the Columbia Sugar Co. which has been evaporating its Steffens waste water for the recovery of potash.

WOOD DISTILLATION

Michigan ranks in the first two or three States in the quantity of wood distilled. This is largely centered in the Upper Peninsula, though there are some wood distillation plants in the Lower Peninsula. E. I. du Pont de Nemours & Co. has plants at Bay City and Brayling. The Cleveland-Cliffs Iron Co., the Charcoal Iron Co. of America and the Lake Superior Iron & Chemical Co. all operate plants in the Upper Peninsula for the distillation of wood. Michigan plants produce finished acetone, wood alcohol and gray acetate of lime. In connection with many of the plants are also charcoal blast-furnaces.

PAPER

Michigan is a very important paper State. The district around Kalamazoo and from there west to Lake Michigan is the most important book paper district in the country. At one place or another in the State nearly every kind of paper is made, but the principal output is book paper.

There is no mill in the State making soda pulp. Sulphite pulp is made by both the slow and the quick cook process. The reworking of old paper is a very important feature of most of the mills. There are boxboard and strawboard mills, one concern makes parchment papers of all sorts, and another makes a specialty of unusual finishes and colors for covers, photograph mounts, etc. There are 30 to 35 paper mills in the State.

One interesting feature of the paper industry is that it is the second industry in the State to unite in maintaining co-operative research. The Michigan Gas Association has for many years maintained a research laboratory and fellowship funds at the University of Michigan, and in 1915 a group of paper manufacturers united to found such an arrangement for the paper industry. The war has greatly interfered with the plans, as might be expected, so that not nearly as much has been accomplished as in the same length of time had conditions been normal.

DYES AND ORGANIC CHEMICALS

The State has two dye plants—the Holland Aniline Co. and the Dow Chemical Co. The Holland Aniline Co. confines itself to a few dyes, including methyl violet, sulphur browns and blues, and bismark brown. The Dow Chemical Co. has long been a producer of chloroform, the manufacture of which was indicated by its production of chlorine in connection with the bromine process. From this, at the beginning of the war, it was only a step to other simple organic chemicals, then the more complex ones, and finally dyes.

PAINTS AND VARNISHES

The State contains two of the largest paint and varnish plants, together with a number of smaller ones. The Acme White Lead & Color Works and Berry Bros., both of Detroit, are among the most important plants in the country in their respective lines. There are also the Boydell Bros. White Lead & Color Co., the Detroit Graphite Co., the Detroit White Lead Works and the International Color & Chemical Co.

TANNING AND TANNING MATERIALS

There is a large number of tanneries all over the State. All kinds of leathers are made—sole leathers, belting, harness, as well as uppers and fine leathers. Chrome, oak, hemlock and tropical extracts are used.

The Michigan Tanning & Extract Co. operates a number of plants, mainly in the Upper Peninsula, for the manufacture of tanning extracts from hemlock bark. The bark is leached in open tanks, and the extract concentrated in multiple effect evaporators.

OTHER ORGANIC INDUSTRIES

The U. S. Rubber Co. has a plant in Detroit—the Morgan & Wright plant—making rubber tires of every description. The manufacture of pharmaceutical products is represented by Parke, Davis & Co., the Frederick Stearns Co. and the Digestive Ferments Co., all of Detroit.

The Franck Chicory Co. has several plants through the State for the manufacture of chicory products. The famous plants at Battle Creek making all sorts of special and standard food products must be remembered. There are several plants for the making of condensed milk; and in the southwest part of the State is an important grape district in which are grape-juice plants. And in this connection it is possibly appropriate to mention the Detroit Reduction Co., which takes Detroit's garbage and converts it into fertilizer and grease by the ordinary process of digesting with steam under pressure.

Ceramic Products

Michigan has plenty of clays, but has little in the way of ceramic industries except the manufacture of common brick. There are a few tile plants, but as a general thing the clay-working industries are confined to ordinary building brick.

Cement and Building Materials

The manufacture of portland cement in Michigan was begun in 1896. In 1901 the State made 1,000,000 bbl., and was the third largest producer in the country. In the last ten years its rank has been fifth to eighth, and it has made from 4 to 5 per cent of the total output of the whole country. Owing to the fact that the important limestone deposits are in the northern part of the State and relatively inaccessible, most of the plants use marl. One plant successfully used the residue of calcium carbonate obtained in making NaOH from Na_2CO_3. This is the Wyandotte Portland Cement Co., operating on the waste from the Michigan Alkali Co. In all, there are 11 active plants making portland cement in Michigan. Table VI gives the Michigan cement production for the years 1913 to 1917 as compared with that of the total in the United States.

TABLE VI—MICHIGAN CEMENT INDUSTRY

Year	No. Mills	State's Rank	No. Kilns	Daily Capacity Bbl.	Total U. S. Production Bbl.	Michigan's Production, Bbl.	Michigan's per Cent of U. S. Total
1913	11	8	83	19,900	92,097,131	4,186,236	4.21
1914	11	7	77	19,100	88,230,170	4,285,345	4.85
1915	11	5	71	20,800	85,914,907	4,765,294	5.55
1916	11	7	68	20,650	91,521,198	4,919,023	5.37
1917	11	7	..	......	92,814,202	4,688,899	5.06

Gypsum is always present in salt beds, and is the principal source of trouble in salt making. As one superintendent put it, "When the Lord made salt beds He put some gypsum in so that the salt maker wouldn't have too easy a time." And the small amounts of gypsum that form on the tubes and pipes in salt plants probably represent more time and money than all the gypsum produced as a primary product. However, Michigan has deposits of gypsum that are worked for gypsum as such. Eight plants handle this material, making land plaster, plaster of paris and special forms such as blocks, tile, etc. In the last ten years Michigan has been in third or fourth place in this country in quantity and value of gypsum products produced. Table VII gives the Michigan gypsum production for the years 1913 to 1917 as compared with that of the total in the United States.

TABLE VII—MICHIGAN GYPSUM INDUSTRY

Year	Ground to Land Plaster, Tons	Calcined, Tons	Sold as Crude, Tons	Total Production, Tons	Total U.S. Production, Tons	Mich. Rank	Mich. per Cent of U.S. Total
1913	9,604	278,368	60,706	423,896	2,599,508	3	16.3
1914	9,322	249,648	61,227	393,006	2,476,465	3	15.9
1915	9,799	245,484	69,572	389,791	2,447,611	3	16.0
1916	9,072	292,109	80,298	457,375	2,757,730	3	16.6
1917	7,090	257,588	61,065	375,803	2,696,226	3	13.9

The State has many deposits of limestone that are worked; varying all the way from extremely high calcium material to dolomites. The sugar industry of the State is almost entirely supplied with high calcium limestone from the northern part of the Lower Peninsula. The Solvay Process Co. gets its limestone from Sibley, a few miles below Detroit, while the Michigan Alkali Co. brings its limestone from Alpena.

In spite of its many deposits of brick clays, Michigan has been the first State in production of sand-lime brick since the process was introduced in this country. Michigan produced 26 per cent of the total for the United States in 1917. There are ten or twelve plants in the State, making building brick almost exclusively.

During the war, when every effort was being made to get optical glass with the maximum transmission, so that when made into periscopes and range finders the range of vision might be as great as possible, the principal problem seemed to be to keep minute traces of iron out of the glass. In their search for iron-free raw materials, the glass people finally came to Michigan for their sand. The American Silica Co., operating a deposit near Detroit, was able to furnish a purer sand than any other deposit in the country.

Conclusion

The enormous growth of the automobile industry has stimulated every form of metal working and fabricating industries; which means that there is a corresponding demand for the products of the various chemical and semi-chemical processes. For of the chemical and related industries it is especially true that they produce supplies for other industries; in few cases do they make articles which go directly to the ultimate consumer.

With the chemical industries resting on the sure basis furnished by the salt and alkali industries, and the markets assured by the enormous general manufacturing interests of the State, there seems to be a very bright future for Michigan as a great technical State.

An American Chamber of Commerce for Havana

A plan is apparently assured to form an American chamber of commerce at Havana similar to organizations of this kind at Paris, London and several other cities.

It is intended to have the work of the organization extend to all parts of the island and to make it a factor of much value in American trade. It is believed that the organization can be of service in matters of transportation, prompt passage of merchandise through the customs, credits, advertising, etc.

The American Minister has been active in bringing about the new organization, in the interests of which the first meeting was held at the American Legation and attended by more than 100 American citizens. At this meeting, held on July 15, 1919, a temporary organization was effected, and at an early date it is expected to complete the organization and secure suitable quarters and a permanent secretary and such other assistants as may be required. The consulate general is taking an active part in the new project and will be able to render much assistance to it.

Natural and Industrial Resources of Wisconsin

A Description of Some of the Mineral Resources and a Review of Some of the Chemical Industries—Present Status of the State's Zinc Industry and Prospects for Future Development

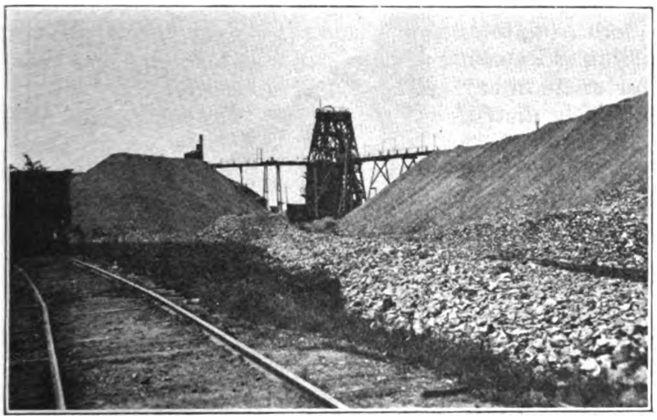
Raw Material Resources of Wisconsin

By W. O. Hotchkiss
State Geologist

WISCONSIN is very close to an average State in almost all particulars. The average State should have a standing of about 2 per cent, and since there are 48 States Wisconsin has more than her 2 per cent of wealth and population and almost exactly 2 per cent of the area of the United States. In raw mineral reserve products, however, Wisconsin has only about half of the average of the country, its total mineral production being about 1 per cent of that of the United States. Of the important mineral resources, Wisconsin produces no coal, no copper and no precious metals, so barring these from the list of products of the country Wisconsin has considerably more than the average State in production of raw mineral materials.

Zinc Ores

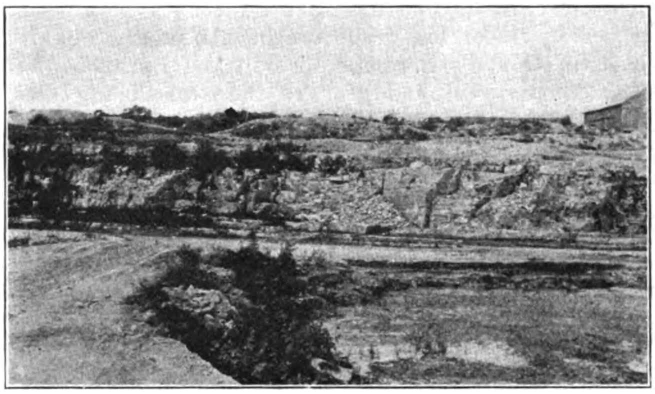
The principal mineral resources of Wisconsin are zinc, iron and stone. Before the World War zinc ore and iron ore were approximately equal in value, but owing to the great demand for zinc during the war the production of that metal increased nearly four times in value, so that in 1918 the zinc ore produced in this State was worth over $5,000,000. In 1916 and 1917 the value each year was between $7,000,000 and $8,000,000. The metal content of the ore was worth approximately double the value of the raw material. On account of this great development in the zinc industry it is now the largest single item in value of the mineral production of the State. Zinc mines are located in the southwestern portion of the State and the district overlaps a little into the adjacent States of Iowa and Illinois.



WINDSOR MINE

On the average, the zinc mines are less than 200 ft. in depth, and as the ore comes from the mine it contains considerable limestone, and iron sulphide in the form of marcasite. The limestone is eliminated by concentration, and the marcasite and zinc sulphide are then sent to a roaster in which the marcasite is given a magnetizing roast and separated from the zinc sulphide in a magnetic separator. During the war plans were made for installing contact acid plants to use the gas from some of the largest roasters. Some of the mines have their own roasters, but many of them ship their ore to central plants, where the marcasite is removed from the zinc sulphide.

The principal production of zinc is from the mines of strong companies. The Mineral Point Zinc Co., a subsidiary of the New Jersey Zinc Co.; the Wisconsin Zinc Co., a subsidiary of the American Zinc Roasting & Smelting Co.; the Vinegar Hill Zinc Co.; the Frontier Mining Co.; and the Field Mining & Milling Co. produce approximately three-quarters of the total zinc production. Each of these companies operates several mines.



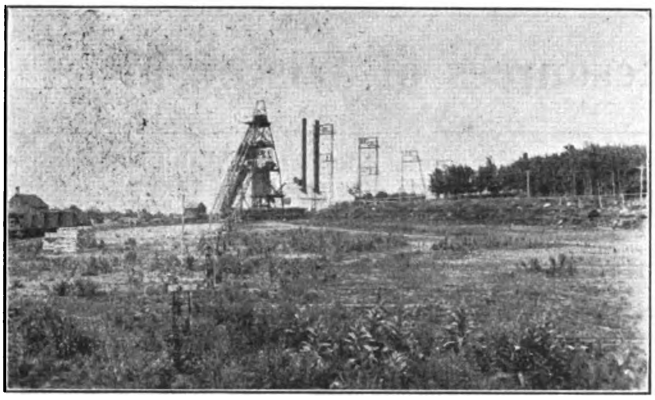
GRANITE QUARRY AT BERLIN

The crude ore before milling varies greatly in zinc content. Some mines will produce as little as 5 per cent of concentrates from the ore and others will produce more than 20 per cent of concentrates. In some cases, while running on especially rich ore bodies, a much higher percentage of concentrates is recovered. The ore going to the mill is much richer than the Joplin ore.

In the northern portion of the district, in the vicinity of Highland and Mineral Point, some portions of the ore bodies have been altered to zinc carbonate. This finds a ready market at the zinc oxide works of the Mineral Point Zinc Co. at Mineral Point, Wis., which is one of the largest zinc oxide plants in the United States and draws its ore supplies not only from this district but from the far West and Southwest, and even from Mexico.

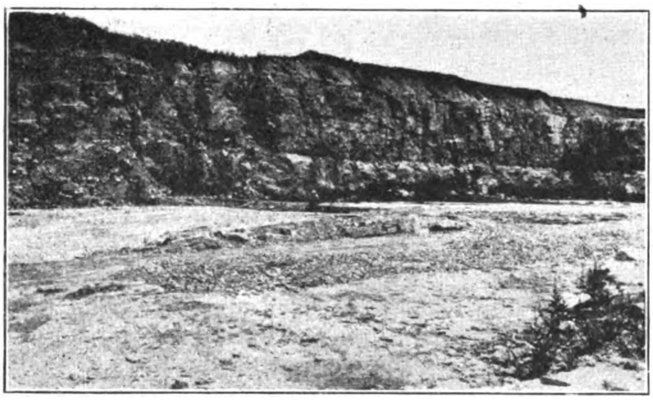
Iron Ores

The iron ore of Wisconsin is produced at present from four districts. The largest tonnage comes from the Gogebic Range, which lies in the extreme northern part of the State and extends over into Michigan, where



MONTREAL HEAD FRAME

the main production of the Range is secured. In the northeastern corner of the State, in Florence county, there is a small production, and in the Baraboo Range, in the south central part of the State, there is one operating mine. All of these ores are Huronian and of the usual Lake Superior type. In Dodge county, about 50 miles northwest of Milwaukee, there are Ordovician ores similar to those in Birmingham. These are of a much lower grade than the Lake Superior type of ore. Large reserves of low-grade ore have been thoroughly proved in this district, and also in the Baraboo district. There are in addition to these producing districts a number of districts in the State which offer great promise for the production of iron ore when concentration of low-grade material is undertaken. In the western end of the Gogebic Range and in the Black River Falls district there are literally hundreds of millions of tons of magnetic formation that will doubtless be concentrated before many years.



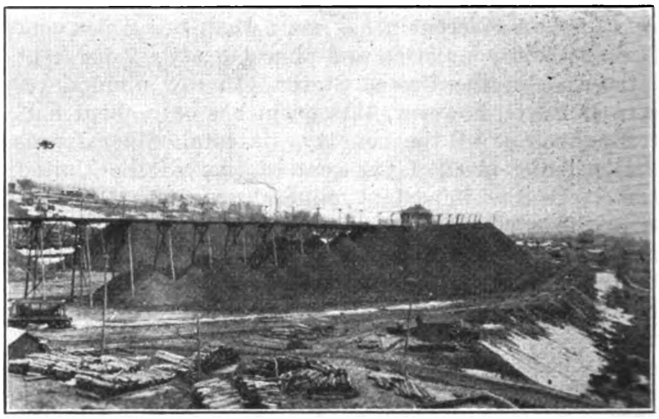
BRILLION LIMESTONE QUARRY

Possible Undiscovered Iron Ranges

In the northern half of the State there are great areas in which the glacial drift entirely obscures the rocks but in which there are doubtless to be discovered important iron ranges. The State Geological Survey has been carrying on for the last eight years a comprehensive program of geological and magnetic study of this portion of the State for the purpose of discovering all areas in which exploration appears to be warranted. Exploration which has followed upon published reports has proved the existence of Huronian rocks such as are associated with the Lake Superior iron ores, so that definite proof has been secured that there are first-rate opportunities for the discovery of new iron ranges. Only a small fraction of the total area to be examined has as yet been covered.

While Wisconsin is not in a class with Minnesota as an iron ore producer, it ranks fifth among all the States, and its annual production, if loaded upon the largest size of ore cars, would make a continuous train from the State line north of Chicago to Milwaukee, and from Milwaukee clear across the State to La Crosse. With its large reserve of low-grade ore, and the opportunities for the discovery of other Lake Superior iron ranges in the little known northern portion of the State, Wisconsin promises to stand high as an iron ore producer for many years.

Widely distributed over the glaciated northern portion of the State are marshes which contain bog ore. This ore is usually in comparatively shallow deposits of a few inches to a few feet in depth, but its character is such that it may in the future have a large value for special purposes.



ROCK PILE NEAR NO. 4 SHAFT, MONTREAL MINE

Stone Production

The third in rank of Wisconsin's mineral resources is its stone production. If under stone one included similiar products and the derived products, such as lime, sand and gravel, Wisconsin's stone production would be worth more than its iron ore. In these days of concrete construction and extreme activity in highway building Wisconsin is fortunate in having widely distributed over four-fifths of the State excellent glacial sand and gravels; and over the unglaciated portion, and in a considerable part of the glaciated portion as well, abundant local supplies of limestone, trap rock and granite, which make the best of materials for highway and structural purposes. In 1917 Wisconsin produced over $1,000,000

STURGEON BAY STONE QUARRY

worth of lime. Nearly $870,000 worth of this was used for building purposes, about $90,000 worth was used in the manufacture of paper, and large amounts were supplied to blast-furnaces for flux, to chemical works, to tanneries, and to glass factories, and there is a small but rapidly growing use of this material as a fertilizer for sour soils. Limestone was produced in the State to a total value of nearly $1,200,000 in 1917. Nearly three-quarters of this value was represented by crushed stone used for road making and for concrete construction. The largest other item was flux for blast-furnaces, with almost equal values for the production of rubble and riprap stone. Rough and dressed building stone was produced in minor amounts, and small amounts of limestone were used for paper mills and agricultural purposes.

LIMESTONE QUARRY NEAR WAUKESHA

THE STATE'S GRANITE RESOURCES

Wisconsin possesses important resources in granite, some of the finest monumental stone in the world and the hardest and most durable granites being quarried in the State. The total production in 1917 was valued at $1,250,000. Of this total minor values were represented in rough stone, rubble, riprap and crushed stone amounting to somewhat over $150,000. The remainder, about $1,100,000, was almost evenly divided in value between dressed and monumental stone and paving blocks. Wisconsin paving blocks are used in all the principal cities in the northern Mississippi Valley, as far south as St. Louis and as far east as Cleveland.

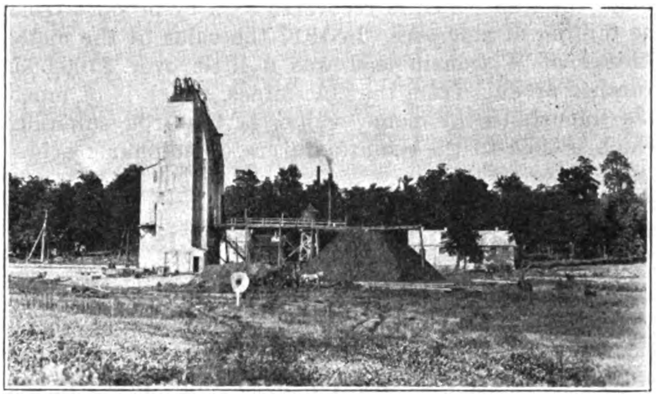
In 1917 Wisconsin produced nearly $300,000 worth of sandstone and ganister. Over half of this value was quartzite used for the manufacture of refractory brick and produced in the vicinity of Baraboo. This quartzite is very pure silica, seldom containing as much as 1 per cent of impurities, and its pure and refractory character make it especially valuable for bricks for furnace linings. Some of Wisconsin's sandstones make excellent building stone of a beautiful, soft light buff color. When the war cut off the supply of foreign material, stone from Wisconsin's sandstone quarries was selected to be used for finishing a cathedral in New York City.

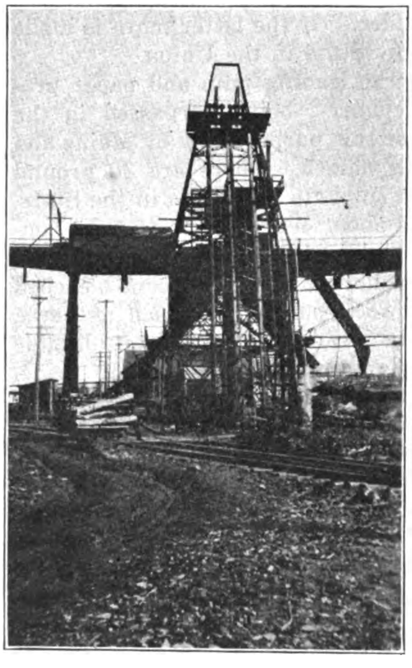
Wisconsin gravel is widely distributed over the State and is used in vast quantities for road construction. Nearly $500,000 worth was used for this purpose in 1917, which represented nearly 1,500,000 tons. Nearly 500,000 tons, valued at $67,000, were used for railroad ballast. Considerable quantities of sand were used for molding sand and paving sand, and nearly 300,000 tons were used for building sand. The total value of sand and gravel production in 1917 was nearly $1,100,000.

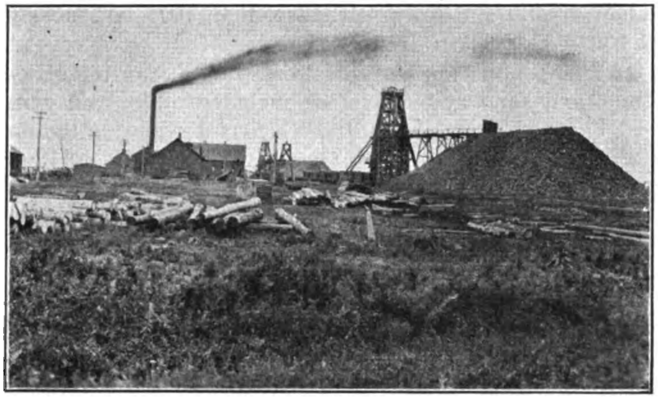
If the production of limestone, lime, granite, sandstone, and sand and gravel be included under the general head of stone industry, Wisconsin's production in 1917 was valued at approximately $4,800,000. These figures are for value at the quarry or pit and do not include any transportation charge. If transportation to the consumer were included as a part of this industry, the stone industry in Wisconsin could be said to bring in nearly $15,000,000 a year to its citizens.

OTHER RAW MATERIALS

Mineral waters of Wisconsin are world famous. In former days when the discreet citizen decided that he had enough of stronger fluids he was very likely to ask the bartender to fill his glass with a world-famous brand of Wisconsin mineral water. Wisconsin mineral waters are shipped all over the world, and in both quantity and value Wisconsin leads all other States in the Union. In 1917 the total production at the spring was valued at $1,362,000, an average price per gallon of 22c. This was less than the usual production because of the stoppage of world trade by the war. The main production of Wisconsin's mineral waters comes from the city of Waukesha. The clay products of Wisconsin include chiefly brick and tile, and the value of the production in 1917 was $1,114,000. The glacial clays of Wisconsin are very abundant, and there are small local brick plants, with a few large plants, which supply considerable areas. These clays are not suitable for fire brick or paving brick, but a good quality of front brick is made in some of the yards.


MAYVILLE SHAFT, NORTHWESTERN IRON CO.


NO. 4 HEAD FRAME, MONTREAL MINE



CARY MINE AND STOCK PILES

Next in order of Wisconsin's mineral production comes the lead which is recovered as a by-product from the milling of zinc ores. In 1917 the value of the metal content of Wisconsin lead was a little over $700,000. Another product from the zinc mines, which is of much less importance in money value, is the iron sulphide, which is sold to the manufacturers of sulphuric acid.

There are deposits of carbonaceous schists in Wisconsin, in which the carbon has been very much altered so that it is clearly graphitic. One of these deposits has been used for the manufacture of a very good grade of graphite paint.

LARGE AREAS OF PEAT BOG

An undeveloped mineral resource of Wisconsin which bids fair to be of great importance in the future for a wide variety of purposes is found in its great areas of peat bog. The State Geological Survey examined peat bogs of a total area of 121,000 acres, in which it was estimated that there is available at least 150,000,000 tons of air dried peat. It was further estimated that there are over ten times as many deposits as were examined, and a general estimate is given that there are between 2 and 3 billion tons of dried peat available in Wisconsin. Much of this will doubtless be drained and used for agricultural purposes, for which it makes very valuable soil, but as the chemical industry in this country increases chemists are bound to find more valuable uses for large quantities of this material.

Chemical Industries of Wisconsin

By O. L. Kowalke

A WIDE variety of chemical industries is represented in Wisconsin, but among these the leather and paper industries are the most important on the bases of value of product and number of men employed.

The leather industry of Wisconsin ranks fourth among all the industries of the State and third in the leather industry of the United States. The employees constitute 10.5 per cent and the value of the products, $42,200,000, constitutes 11.5 per cent of the total for the country in 1914. Milwaukee is the second city in the country on the bases of size of tanneries and the value of the products. The principal product is "calfskin upper," 2,292,800 sides, of which more is made here than in any other State; sole leather, with 1,122,200 sides, comes next in order, and is followed by harness leather, with 631,787 sides. Of the latter more is made in Wisconsin than in any State in the Union.

Wisconsin is one of the leading pulp and paper producing States in the country, being surpassed in the consumption of wood for this purpose only by Maine and New York in the order named. There are 30 ground wood, 20 sulphite and 5 sulphate pulp mills in the State, which in 1917 produced about 400,000 tons of pulp, consisting of 45 per cent unbleached sulphite, 38 per cent mechanical, 8 per cent sulphate and 9 per cent bleached sulphite. Besides the wood pulp paper, such as news, writing, book, tissue, wrapping, etc., considerable amounts of rag paper and container board are made, amounting in all to 480,851 tons in 1917. A number of specialties were developed in Wisconsin for war purposes, such as cellu-cotton, a wood pulp substitute for absorbent cotton; special waterproof containers for packing and shipping shells and other war supplies, and the use of waste hemlock bark, produced from the rossing of wood, for the manufacture of hemlock extract. Other specialties, not for war purposes, are fiber rugs, filter mass (the plant being the largest in the United States), and molded pulp products.

There are several chemical industries that rank well to the front in the country. Of these the rubber industry ranks sixth in the value of products, $7,382,108, for five establishments in 1914, the principal product being automobile tires. The 11 soap factories, with an output valued at $2,894,000, rank tenth in the country in this industry on the bases of persons employed and value of the products. The increase in value of the finished products over the raw materials is 117 per cent. In this respect Wisconsin is led by only one State, which gives a measure of the high grade of soap made. Gas for domestic and municipal consumption made in 47 plants is valued at $5,294,000, which puts the group in tenth place in the industry. Not included in the group of 47 gas plants are two by-product coke-oven plants, in one of which 250 ovens are in operation, producing 1800 tons of coke daily.

The census of 1914 ranks Wisconsin nineteenth in a group called chemical industries, comprising 395 establishments engaged in the manufacture of acids, sodas, alums, coal-tar products, cyanides, bleaching materials, chemicals by electrolysis, plastics, compressed and liquefied gases, and other chemicals. Most of these materials are made here. Sulphuric acid is made in two plants, one using the contact process; nitric acid is made in one plant; three plants are engaged in making bicarbonate and sal soda. The compressed and liquefied gas industry has kept pace with the growth of the foundry and machine tool industry; two plants make compressed acetylene; two make compressed oxygen and hydrogen, while at one plant of considerable size compressed oxygen is obtained from the air.

MISCELLANEOUS OTHER INDUSTRIES

Another group of industries not included in the above list but of equal importance is worthy of consideration. Of major importance in this group are four beet sugar factories having a combined daily capacity of 2800 tons of beets; one glue factory capable of handling all the wastes from the Wisconsin tanneries in addition to large amounts of raw materials shipped in from other sources; and a match factory of large capacity. The dry battery industry ranks third in its group and its output is about 2 per cent of the total in the country. In the manufacture of dynamite and permissible explosives, Wisconsin ranks sixth among the seven States producing nine-tenths of these commodities. Other industries on which statistics are not available include the following:

Industry	Number of Establishments	Industry	Number of Establishments
Lime	30	Wood alcohol and acetate of lime	3
Fertilizers	8	Glycerine	2
Paints ready to use	6	Insecticides	2
Iron buff and other colors	3	Baking powder	2
Zinc oxide	1	Electroplating	10
Varnish	1	Glass bottles	1

A number of industries were established as a result of the war. Among these is the production of potash from wood ashes. In 1917 21 plants were in operation in Wisconsin and 25 in Michigan, which together produced 1035 short tons of crude potash, or 2 per cent of the total potassium oxide production in the United States. The initial cost of the average sized potash plant, including the building, was between $3000 and $4000.

The production of high explosives in Wisconsin in 1916 amounted to 6,515,032 lb., which was 2½ per cent of the total manufactured in this country. Closely associated with the production of high explosives is the manufacture of coal-tar dyes and dye intermediates in one large plant. This plant made a number of intermediates in large quantity and is now well established for peace-time production.

Laboratory of Chemical Engineering,
University of Wisconsin.

Zinc in Wisconsin

By A. M. Plumb

PROBABLY the history of few mining districts could be as definitely divided into two epochs as that of the Wisconsin zinc mining district. From the advent of the whites into the section in the last quarter of the seventeenth century up to the end of the nineteenth century, the district was practically a lead district. The history of the pioneer lead miners and smelters up to the beginning of the twentieth century has been fully covered by numerous writers, and in most cases these histories are closed with the nineteenth century, which marks practically the beginning of the zinc industry, and simultaneously the ending, to all intents and purposes, of the lead industry.

There is, of course, an important lap of these epochs in the case of the Mineral Point Zinc Co. At Mineral Point numerous efforts have been made to produce zinc metal and zinc oxide, which have all been described, from which has evolved the present Mineral Point Zinc Co., which has discontinued any attempts to produce metal, but has been successfully producing oxide by the old Wetherill process for many years, ores being derived from numerous distant points, even as far south as New Mexico, and as far west as Nevada.

Production of Zinc From Mixed Sulphide Ores

At the beginning of the present century, the possibility of producing zinc from the mixed sulphide ores attracted the attention of miners and metallurgists from many different mining sections of the country. The presence of pyrite and marcasite was so general as to make the direct production of smelting concentrates out of the question, except in rare, isolated cases. In the early '90s an effort was made to effect a separation of the zinc blende and marcasite by a secondary treatment. Prof. R. P. Blake, who had some advance information on the physical properties of the Wisconsin marcasite, attempted to separate these products by a preliminary roast followed by a wet jigging operation. On account of the fact that the marcasite particles when roasted are affected in a manner very similar to the effect upon popcorn when subjected to heat, hydraulic diameters of these are materially changed. Particles after roasting will be found to have numerous fissures extending toward the center of the particle, and, in addition to the fissures, the whole mass is left in the form of a sponge. While it is probably a fact that this particle will have slightly less specific gravity than the blende particle, its shape and structure is such that it will be found to ride considerably higher on a jig bed than will the zinc.

This attempt resulted in some surprisingly high grade finished product, but the loss of zinc in tailings was so great as to render the process of practically no economic value. This excessive loss was almost entirely a loss of fines. While the resultant product of a jigging separation in Wisconsin is considered coarse, i. e., all through a ⅜-in. screen, the roasting operation produces a considerable amount of extreme fines on account of decrepitation, and most of this in the process above described will be lost.

Ores Separated Magnetically

Early in 1900 some experiments were made which resulted in the present successful separation of these ores, which is accomplished by a preliminary roasting and subsequent magnetic separation. The first commercial attempt along this line can easily be considered a complete success. The operation consisted in passing the ore through a revolving type of furnace similar to a Howell-White, but having a dam at both the feed and discharge ends to retain a quantity of ore in the cylinder so that the passage through the apparatus was retarded. The roasted product is then passed to almost any of the types of magnetic separator, resulting in a surprisingly complete separation.

This process was considered a part of the standard equipment in the Wisconsin field until the year 1915, when the Wedge type multiple hearth roaster was introduced, with great success, after the minor initial difficulties had been surmounted. The savings, however, over the older process have been practically negligible aside from the dust loss. In the old type of furnace the dust loss was substantially 5 per cent, whereas in the new type it is about 1 per cent. The separations effected are practically identical.

I have mentioned that the simultaneous occurrence of marcasite and zinc blende was the great problem in the beginning of this industry. It is then somewhat surprising to discover the extreme kindness of nature when the process is finally evolved, in that a very large percentage of the objectionable gangue materials is found to be associated with the marcasite. As an example, out of an ore running 39.6 per cent Zn, 15 per cent Fe and 2.9 per cent CaO, the magnetic material discarded as tailings runs 4.8 per cent Zn, 48.5 per cent Fe, 4.9 per cent CaO and 3.35 per cent ZnS. The finished product, containing 95 per cent of the zinc contents of the feed, runs 61.5 per cent Zn, 1.6 per cent Fe and 2 per cent CaO.

This result is accomplished by following somewhat different lines than would ordinarily be attempted. It is the first thought of most metallurgists when difficulties in separation arise to crush to a smaller size. In Wisconsin this turns out to be a mistake, since any additional crushing will liberate some of the lime and insoluble which are components of the marcasite particles, so that finally the separation in Wisconsin is accomplished with best results at as coarse size as the mill product can be produced.

On the other hand, there are some natural properties which if not guarded against will lead to economic loss. The marcasite particle after roasting is made up of a combination of a so-called artificial pyrrhotite and amorphous iron oxide. This latter forms the outside surface and is so soft as to be easily crushed between the thumb and finger. It is then necessary to subject this product to the least amount of handling, since the dust resulting from abrasion is not magnetic and will be found as an iron content in the finished concentrate.

Blake-Moerscher Electrosiatic Process

At about the same time that the magnetic separation was instituted in Wisconsin, a small plant was built for purposes of testing out the Blake-Moerscher electrostatic process. This was an ingenious device, utilizing the differences of conductivity between the zinc blende and the marcasite. This first plant demonstrated that there was a strong possibility of this operation being successful, especially since the iron product had a marketable value as a source of sulphur, and made a salable zinc product.

In 1908 this process made its appearance in a slightly different form in the Huff electrostatic separator. A plant on a moderate scale, utilizing this process, was built and operated with more or less success for 3 years, when the plant was destroyed by fire and was not rebuilt. Probably the one determining factor in the abandonment of this process was the necessity of crushing the mill concentrates in order to effect a separation, which resulted in the liberation of lime and insoluble as described above.

Old and Primitive Methods Prove Best

The district as a whole has furnished its quota of incidents which have added to the general fund of mining and metallurgical experience. It has for the thousandth time been demonstrated here that metallurgists coming in from other districts should avail themselves of the experience of the natives, giving the prevailing methods careful thought before radical changes are decided upon. Nearly all of the mining and milling operations here are of almost primitive type, but when the outsider has attempted to improve materially upon these by any radical change, he has come to grief.

One feature of the average mining proposition here is that it is short lived, which of necessity means the cheapest installation that will make a respectable metal recovery and pay its entire cost, together with a profit, in from 3 to 5 years.

Another lies in the fact that concentrates must be re-treated before marketing. I have said above that nature has been most kind in providing physical properties which ultimately benefit the operation. A further instance of this lies in the fact that in a coarse jigging operation the percentage of recovery of zinc is much higher than that of iron. The average operation results in a metallic zinc saving of from 60 to 70 per cent. This large loss appeals to the outsider at once as an opportunity for radical improvement. He will find, however, in most cases that his efforts, which might be called metallurgically successful, will fail economically due to the fact that the product he recovers will not be worth its cost.

Flotation has not yet made its appearance except in the most superficial experimental way. This process does hold out some promise, especially on some of the larger propositions which have from to to 20 years' life, and I shall be surprised if within a very few years there are not some successful flotation plants operating in this field, especially since the selective processes producing zinc direct from other sulphides show strong promise.

Prospects for Future Development

Among the attractive features of the district—it is a most livable country, is traversed with better than average roads, and life here will be found to hold many compensations over that in the average mining camps. At first blush I should say that more in the way of prospecting and equipment can be accomplished per dollar here than in any other mining section I have seen.

It goes without saying that there have been the usual amount of wildcatting propositions. There have been also the usual well meant but misguided expenditures of capital. Altogether, the district will show a fair return on ventures well managed, and there are no reasons apparent why the present activity should not continue for another century.

Minnesota State-Owned Iron Mines

The following is a list of State-owned properties in Minnesota:

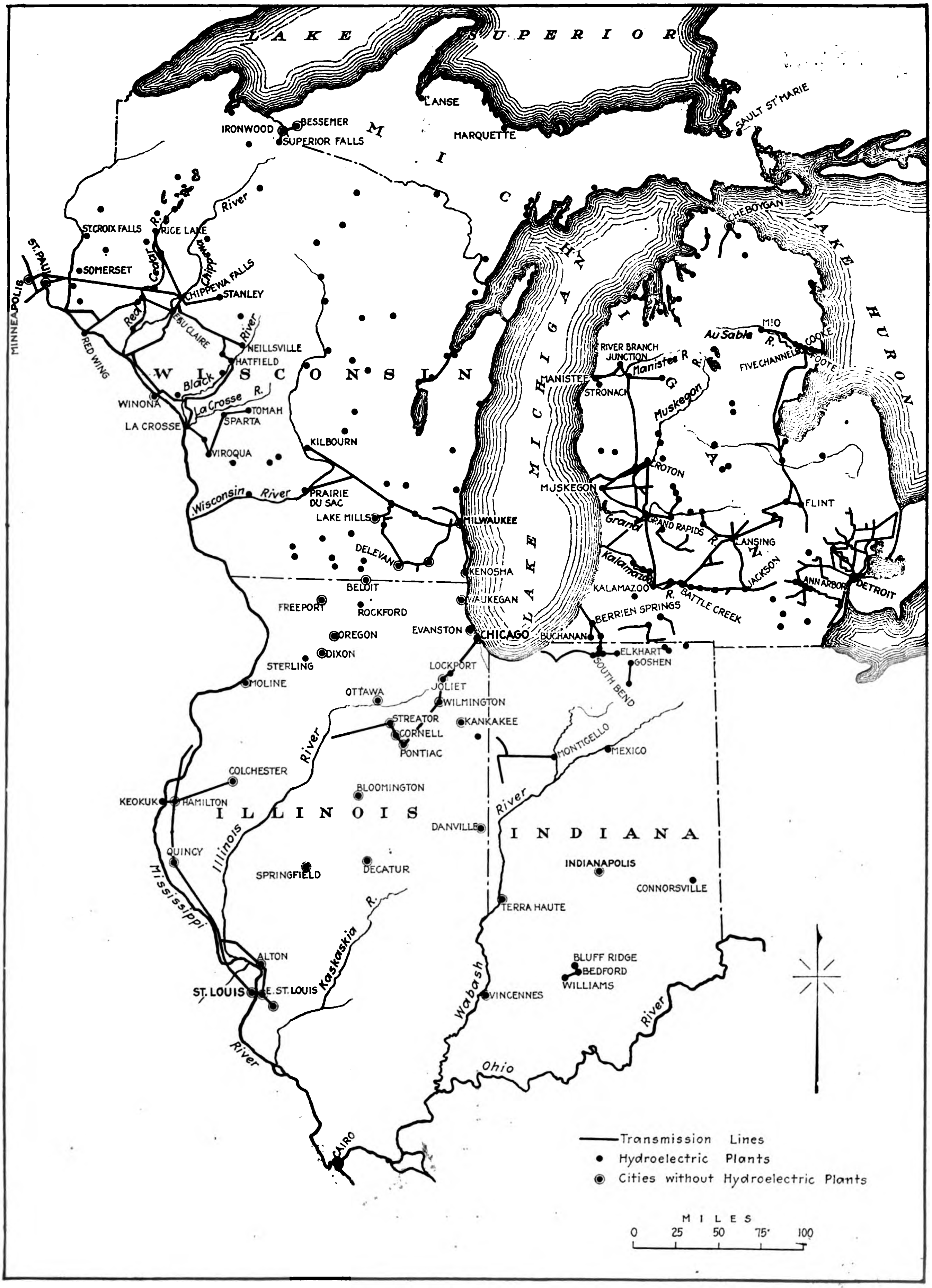
MINNESOTA STATE-OWNED IRON MINES

Mine	Operator	Tons Shipped in 1918
Missabe Mountain	Oliver Iron Mining Co.	1,173,312
Leonidas	Oliver Iron Mining Co.	656,735
Pool	Oliver Iron Mining Co.	191,434
Grant	Interstate Iron Co.	117,407
Hanna	Consumers' Ore Co.	116,082
Woodbridge	Fort Henry Mining Co.	209,414
Wacoutah "A"	Consumers' Ore Co.	174,442
Wacoutah "B"	Consumers' Ore Co.	947
Scranton	Pickands, Mather Co.	....
Helmer	Cleveland-Cliffs Iron Co.	207,643
Duncan	Oliver Iron Mining Co.	5,159
Minnewas	Oliver Iron Mining Co.	....
Fay	Virginia Iron Mining Co.	....
Shiras	Oliver Iron Mining Co.	128.402
Frantz	Consumers' Ore Co.	169,777
Seville	A. B. Coates	7,703
Hill Annex	Interstate Iron Co.	559,727
Kevin	Butler Bros.	21,601
Philbin	Oliver Iron Mining Co.	233,484
Prindle	Oliver Iron Mining Co.	....
Majorca	Hobart Iron Mining Co.	251,999
Morton	Dean Iron Co.	....
Smith	Butler Bros.	39,292
Margaret	Butler Bros.	44,067
Wanless	Oliver Iron Mining Co.	175,587
Draper	Draper Iron Co.	....
Pilot	Hanna Ore Mining Co.	....
Thompson (Cuyuna Range)	Inland Steel Co.	152,648
Martin (Cuyuna Range)	Whitemarsh Mining Co.	1,421
Northland (Cuyuna Range)	Northern Minnesota Iron Co.	....
Total		4,638,283

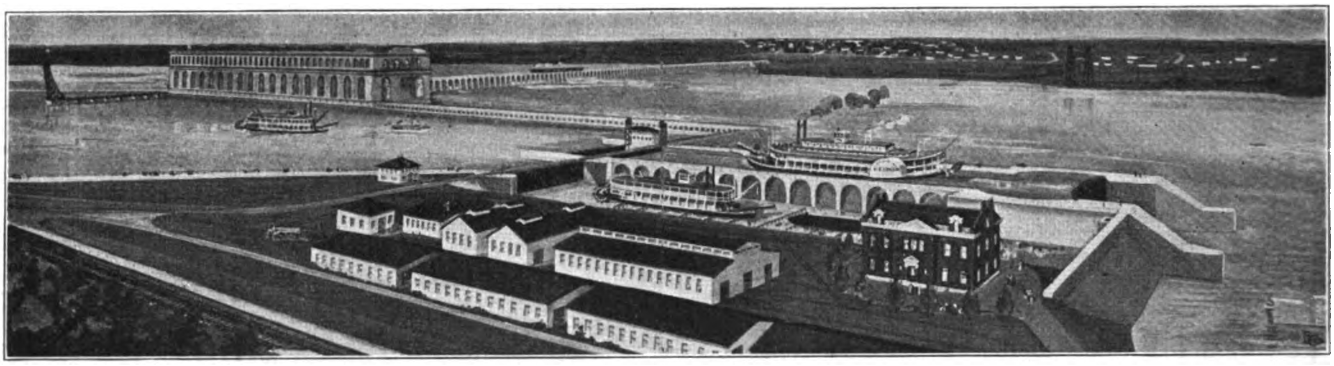
STATE-OWNED MINES NOW EXHAUSTED

Mine	Operator	Total Tonnage Shipped
Alberta	Loly Mining Co.	136,534
Cavour	Cavour Mining Co.	177,952
Section 17	A. B. Coates	20,802
Eaton	Eaton Mining Co.	3,547
Yates	Consumers' Ore Co.	678,990
Sliver	Virginia Ore Co.	174,813
Maderia	Maderia Mining Co.	195,494
Deacon	Oliver Iron Mining Co.	347,511
Total		1,735,643

Engineering and Mining Journal, vol. 108, No. 10, Sept. 6, 1919, p. 389.


LAKE SUPERIOR
L'ANSE
MARQUETTE
SAULT ST. MARIE
IRONWOOD
BESSEMER
SUPERIOR FALLS
MICHIGAN
LAKE HURON
CHEBOYGAN
MIO
Au Sable R.
COOKE
FOOTE
FIVE CHANNELS
ST. PAUL
MINNEAPOLIS
ST. CROIX FALLS
RICE LAKE
SOMERSET
Cedar R.
Chippewa River
CHIPPEWA FALLS
STANLEY
Red
EAU CLAIRE
RED WING
River
NEILLSVILLE
HATFIELD
WISCONSIN
Black River
WINONA
La Crosse R.
TOMAH
SPARTA
LA CROSSE
VIROQUA
KILBOURN
Wisconsin River
PRAIRIE DU SAC
LAKE MILLS
MILWAUKEE
DELEVAN
KENOSHA
BELOIT
FREEPORT
ROCKFORD
WAUKEGAN
EVANSTON
CHICAGO
OREGON
DIXON
STERLING
MOLINE
LAKE MICHIGAN
RIVER BRANCH JUNCTION
Manistee R.
MANISTEE
STRONACH
Muskegon R.
CROTON
MUSKEGON
Grand R.
GRAND RAPIDS
LANSING
FLINT
Kalamazoo R.
KALAMAZOO
BATTLE CREEK
JACKSON
ANN ARBOR
DETROIT
BERRIEN SPRINGS
BUCHANAN
ELKHART
GOSHEN
SOUTH BEND
LOCKPORT
JOLIET
WILMINGTON
OTTAWA
STREATOR
CORNELL
PONTIAC
KANKAKEE
MONTICELLO
MEXICO
COLCHESTER
KEOKUK
HAMILTON
BLOOMINGTON
ILLINOIS
Illinois River
DANVILLE
INDIANA
QUINCY
SPRINGFIELD
DECATUR
INDIANAPOLIS
CONNORSVILLE
Mississippi River
Kaskaskia R.
TERRA HAUTE
Wabash River
ALTON
ST. LOUIS
E. ST. LOUIS
BLUFF RIDGE
BEDFORD
WILLIAMS
VINCENNES
Ohio River
CAIRO
Transmission Lines
● Hydroelectric Plants
◉ Cities without Hydroelectric Plants
MILES
0 25 50 75 100

HYDRO-ELECTRIC SYSTEMS, NORTH CENTRAL STATES



Power Systems of the North Central States

Hydro-Electric Systems and Large Steam Plants in Four States Offer Future for Electrochemical and Chemical Industries—Extension of Transmission Lines Opens Way for Development of Natural Resources

BY CHESTER H. JONES

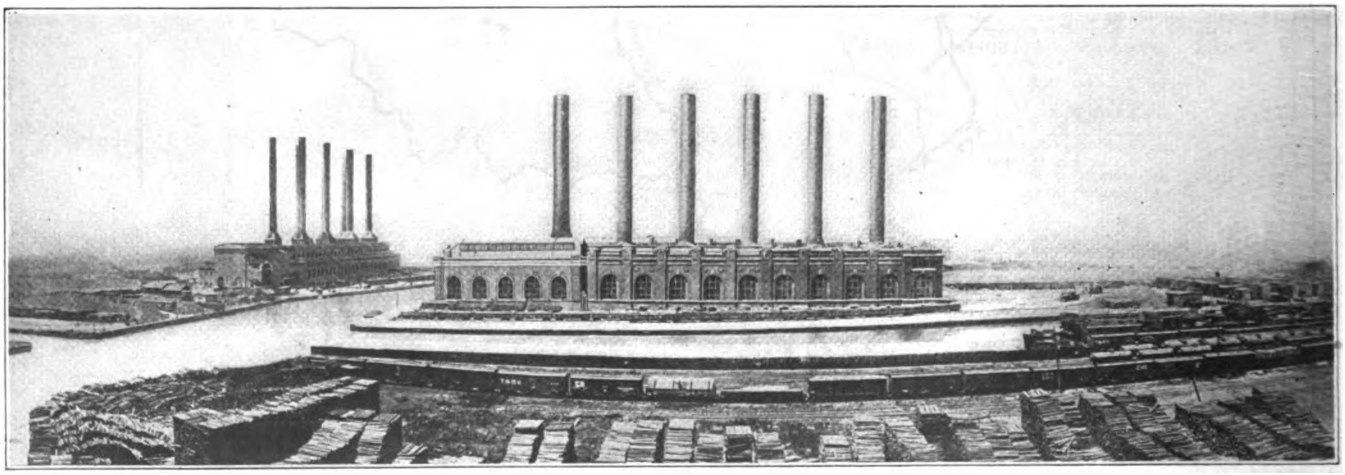
HYDROELECTRIC power in the district of four States of which Chicago is near the center has already become a factor in the development of the chemical industries, and an examination of the potential power resources of those States, individually, reveals the fact that vast coal areas supplying energy through large steam generating units supplement the water power stations to meet the demands of the territory. The district divides itself into the hydro-electric States of Wisconsin and Michigan, and the coal-bearing States of Illinois and Indiana. Keokuk Dam is the exception in the steam power areas. An examination of the map on page 343 will show the relation of local resources in water power to the total power in the United States.

Water-produced electric energy is not of necessity required for electrochemical manufacture. It is not to be forgotten in the consideration of the two sources of energy that a close competitor exists in the steam plant located near the coal supply. A good number of electrical engineers agree that hydro-electric energy transmitted over long distances, and supported by emergency steam plants, is subject to high cost, because of interest on investment, maintenance of line and steam plant and depreciation on system. For the future power of the chemical industry in Illinois and Indiana we must look to the coal fields.

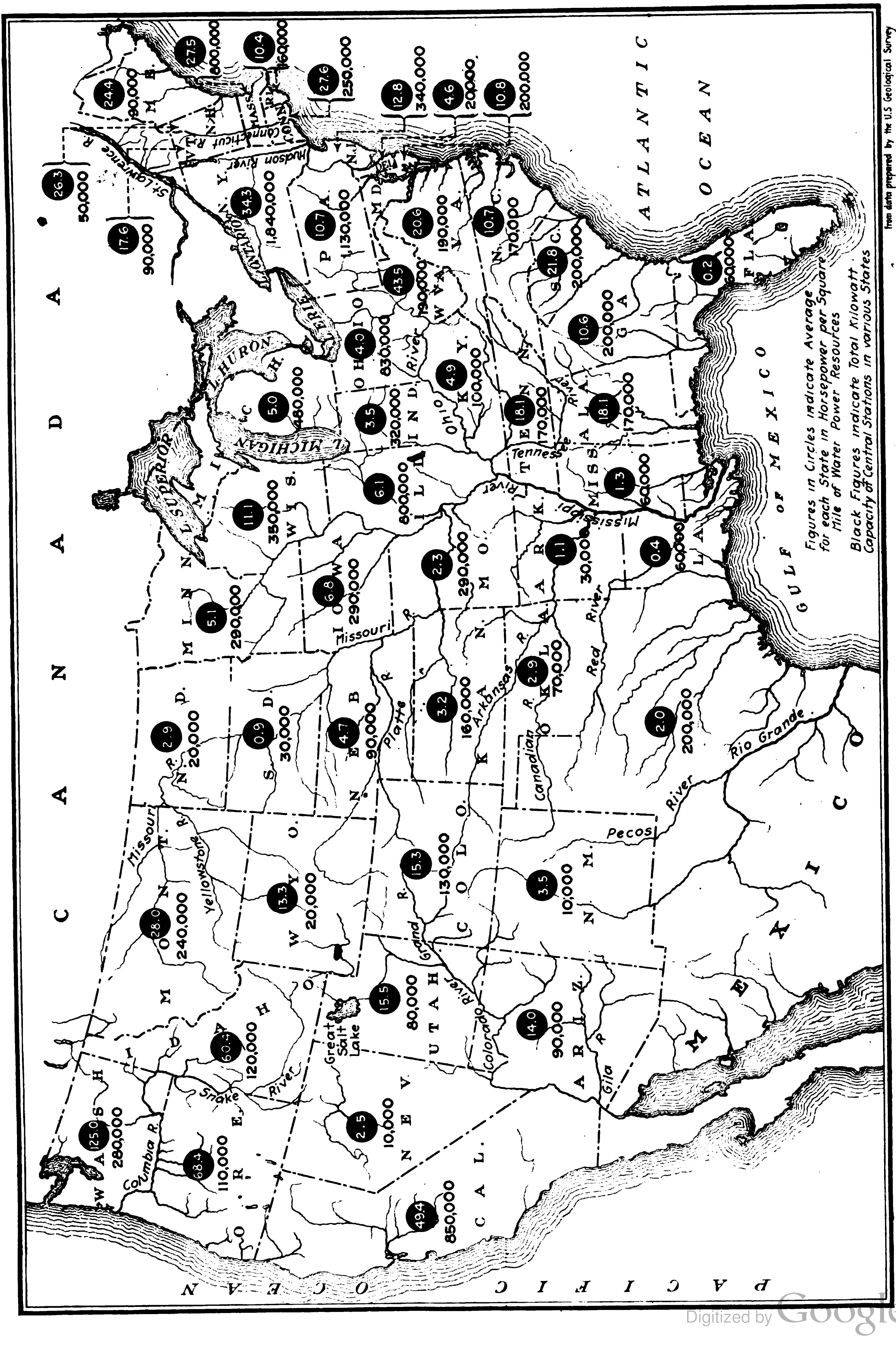
Wisconsin

The State of Wisconsin is peculiarly adapted for water-power development. The slope of the land lies in one direction, commencing at a ridge about 30 miles from and parallel to the shore line of Lake Superior, sloping to the southwest, the entire drainage flowing into the Mississippi River. The many lakes act as reservoirs for each local drainage area, making it possible to hold the storm waters and thus to secure an ideal condition for continuous operation of water-power plants.

The total capacity of generating plants, both steam and water-power, within the State is 350,000 kw., with a possible hydro-electric generating capacity of 613,342 kw. There are now installed 129 hydro-electric plants, the majority of which are of small capacity. The field for future development of water power will be seen from these figures to be enormous.



FISK AND QUARRY ST. GENERATING STATIONS, COMMONWEALTH EDISON CO.

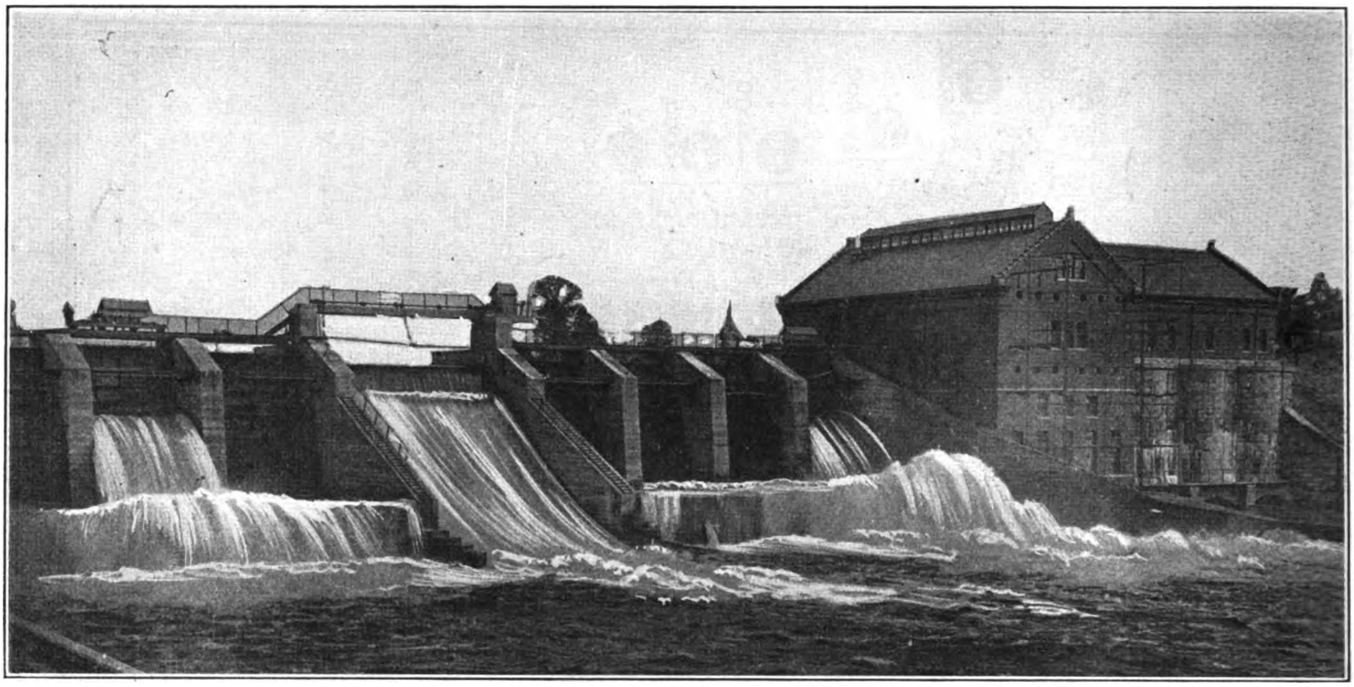

CANADA
ATLANTIC OCEAN
GULF OF MEXICO
PACIFIC OCEAN
MEXICO
M E. 24.4 90,000
27.5 600,000
10.4 16,000
27.6 250,000
12.8 340,000
4.6 20,000
10.8 200,000
26.3 50,000
17.6 90,000
N. Y. 34.3 1,840,000
P A. 10.7 1,130,000
V A. 20.6 190,000
N. C. 10.7 170,000
S. C. 21.8 200,000
FLA. 0.2 60,000
W. VA. 43.5 190,000
OHIO 4.0 830,000
G A. 10.6 200,000
K Y. 4.9 100,000
TENN. 18.1 170,000
ALA. 18.1 170,000
MICH. 5.0 480,000
IND. 3.5 320,000
ILL. 6.1 800,000
MISS. 1.3 60,000
WIS. 11.1 350,000
MO. 2.3 290,000
ARK. 1.1 30,000
LA. 0.4 60,000
IOWA 6.8 290,000
MINN. 5.1 290,000
OKLA. 2.9 70,000
KANS. 3.2 160,000
TEX. 2.0 200,000
NEB. 4.7 90,000
S. D. 0.9 30,000
N. D. 2.9 20,000
WYO. 13.3 20,000
COLO. 15.3 130,000
N. M. 3.5 10,000
MONT. 28.0 240,000
UTAH 15.5 80,000
ARIZ. 14.0 90,000
IDAHO 60.4 120,000
NEV. 2.5 10,000
WASH. 125.0 280,000
ORE. 68.4 110,000
CAL. 49.4 850,000
VT.
N. H.
MASS.
CONN.
R. I.
N. J.
DEL.
MD.
L. SUPERIOR
L. MICHIGAN
L. HURON
L. ERIE
L. ONTARIO
St. Lawrence R.
Hudson River
Connecticut R.
Ohio River
Tennessee River
Mississippi River
Missouri R.
Platte R.
Arkansas R.
Canadian R.
Red River
Rio Grande River
Pecos
Grand River
Colorado River
Gila R.
Yellowstone R.
Snake River
Columbia R.
Great Salt Lake

Figures in Circles indicate Average for each State in Horsepower per Square Mile of Water Power Resources

Black Figures indicate Total Kilowatt Capacity of Central Stations in various States

from data prepared by the U.S. Geological Survey

HYDRO-ELECTRIC POWER RESOURCES IN THE U. S.



CROTON DAM, MUSKEGON RIVER

The extension of transmission lines in the southwestern part of the State is forming an interconnected system, and should eventually serve the consumers as a single unit.

WISCONSIN-MINNESOTA LIGHT & POWER CO.

The Wisconsin-Minnesota Light & Power Co. operates a series of interconnected hydro-electric plants in the western part of Wisconsin, furnishing power, in addition to this district, to Minneapolis and other Minnesota points. The principal generating stations are at Wissota, Eau Claire and Cedar Falls. The largest of these is at the Wissota Dam, located on the Chippewa River at the outlet of Wissota Lake.

The Chippewa River is the greatest of all the power streams in the State, carrying at the Falls a drainage of 5600 sq.m., and the Red River, its tributary, brings an additional drainage from an area of 1997 square miles.

The generating station equipment at Wissota power house consists of six 6600-kw. water-driven vertical generators, together with necessary auxiliary apparatus. Transmission line operates at 110,000 volts, and about 30,000 kw. is consumed by the Northern States Power Co., operating in St. Paul and Minneapolis, Minn.

The stations at Eau Claire and Cedar Falls each contain four 6500-kw. water-wheel generators. Other hydro-electric plants are located at Red Wing, Minn.; Cedar Falls, Chippewa Falls, Menomonie, Neilsville, Rice Lake, Stanley, Viroqua, Sparta, Tomah and La Crosse, Wis. The transmission voltages are 13,200, 33,000, 66,000 and 110,000 volts, and power is supplied to railroad shops, pulp mills, sugar factories, tire factories, iron and steel works, and miscellaneous industries.

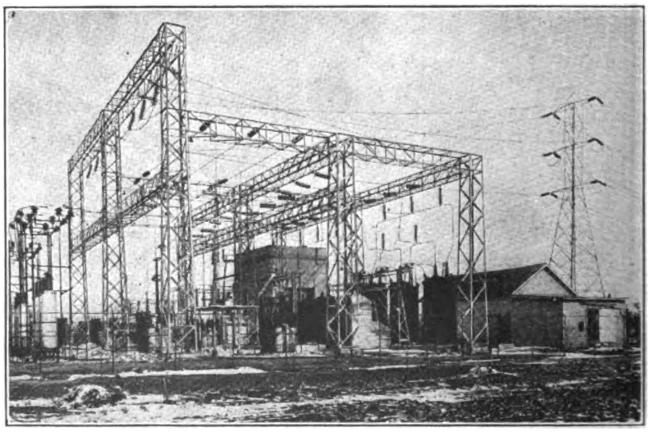
Interconnected with this system is that of the Wisconsin Railway, Light & Power Co., with its water-power plant on the Black River, near Hatfield, below the outlet of Lake Arbutus. The water is taken into the power canal at Hatfield, transmitted 2.6 miles with a fall of 94 ft. to the power house, where it enters through two tubes 10 ft. in diameter to drive two 3200-hp. water wheels. Power is transmitted over No. 2 copper wire to Winona, where it connects with the Wisconsin-Minnesota Power Co. system and with the La Crosse Co.

WISCONSIN EDISON CO.

The property of the Wisconsin Edison Co. consists mainly of steam-power plants interconnected by transmission lines covering the district from Milwaukee west to Lake Mills, south to Delevan and through Burlington back to Milwaukee. A line also extends from Milwaukee through to Kenosha. Power is transmitted at 4000, 13,200, 26,400 and 66,000 volts.

This system receives power from hydro-electric plants of the Southern Wisconsin Power Co. at Kilbourne, utilizing the total output of 6000 kw., and also from the hydro-electric plant of the Wisconsin River Power Co. at Prairie du Sac. This latter station generates a total capacity of 16,500 kw. at 2200 volts, 25 cycle, from a total of six machines.

An examination of the map will show that majority of the water-power plants in Wisconsin are not con-



OUTDOOR SUBSTATION, MUSKEGON HEIGHTS

nected with any considerable lengths of transmission lines, outside of the above mentioned plants. One of the larger plants of the State is at St. Croix Falls, located on the St. Croix River and furnishing power for stations in Minnesota. This station contains six units generating 15,000 kw. and delivering energy to the transmission line at 6600 and 66,000 volts. There is also a station at Somerset on the same river which has a capacity of 3000 kw., with four units all delivering power principally to the St. Paul Co.

Michigan

The State has a total potential water-power resource of 294,500 hp. and a present steam and water power available in generating stations of 480,000 kw. One hundred and sixteen hydro-electric plants in whole or in part are in operation. The majority of these are isolated plants or systems with short transmission lines. The largest system in the territory in number of plants and length of transmission lines is the Consumers Power Co., a Hodenpyl-Hardy property.

CONSUMERS POWER COMPANY

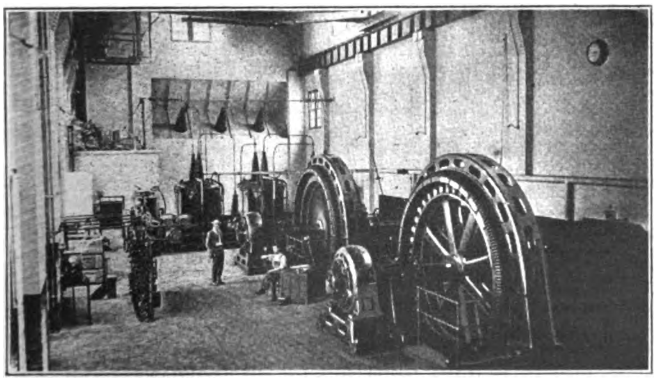
This system, starting with a chain of six water-power generating stations on the Au Sable River, transmits energy south through the Saginaw district, through Lansing to Jackson and Battle Creek, connecting in with six hydro-electric plants on the Kalamazoo River, thence northward to plants on the Grand, Muskegon and Manistee rivers, forming a horseshoe system over the territory of the Lower Peninsula.

One of the large chemical works using this energy is that of the Dow Chemical Co. at Midland, where bromine, bromides, chlorine and miscellaneous chemicals are produced. Other plants along the line are the Michigan Alkali Co. at Wyandotte, manufacturing soda ash, and the North American Co. at Bay City, manufacturing soda ash and chlorine.

The Pennsylvania Salt Co. at Detroit, making chlorine and alkalis, is on the line of the Detroit Edison Co.

Among other developments on the Au Sable River is the Cooke power house. On the southern loop of the system additional energy is generated at Grand Rapids, Jackson, Saginaw, Bay City, Battle Creek, Kalamazoo, Pontiac, Manistee and Cadillac. The hydro-electric plants have an installed capacity of 101,000 hp., and the steam plants 103,000 hp., i.e., the total is equal to nearly half of the total installed power in the State. There are 1400 miles of transmission lines, steel tower construction, located almost entirely on private rights-of-way.

In addition to power furnished for the chemical industries above outlined other prominent industries are factories for automobiles, agricultural machinery, food products, paper and pulp mills, brass and metal products, stoves, wagons, and also electric railways. The field for development of ceramics is said to be large along this property; this is also true of several large undeveloped chemical deposits.


INTERIOR COOKE POWER HOUSE

Among the larger water-power plants in the north are Junction Dam on the Manistee River and Croton Dam on the Muskegon River. The pictures shown herewith give a good idea of the Croton Dam and a substation in this section. Reference to the map will show the proximity of the transmission lines of the Detroit Edison system to this property and doubtless it will not be long until interconnection is made to form a system that will serve the whole Lower Peninsula.

THE DETROIT EDISON CO.

This company is controlled by the North American Co. and operates the largest system of steam generating plants in the State. Energy is also supplied from four hydro-electric plants on the Huron River, near Ann Arbor. The two plants at Detroit generate from steam a total of 198,000 kw. The total water-power capacity near Ann Arbor is 6075 kw.

UPPER PENINSULA PLANTS

The Escanaba Power Co. operates hydro-electric plants on the Escanaba River at Groos, Wells and Chandler Falls with a total of 3750 kw. capacity transmitted at 6600 volts.

There is a 3000-hp. water-power plant under construction at Superior Falls, Wisconsin, for the purpose of supplying energy to Ironwood and Bessemer, Michigan.

A 3700-kw. plant on the Menominee River supplies energy to Menominee over a 3300-volt transmission line. There are also similar plants at Newaygo, for the Portland Cement Co., at Sault Ste. Marie, and at Marquette all in northern Michigan.

Illinois

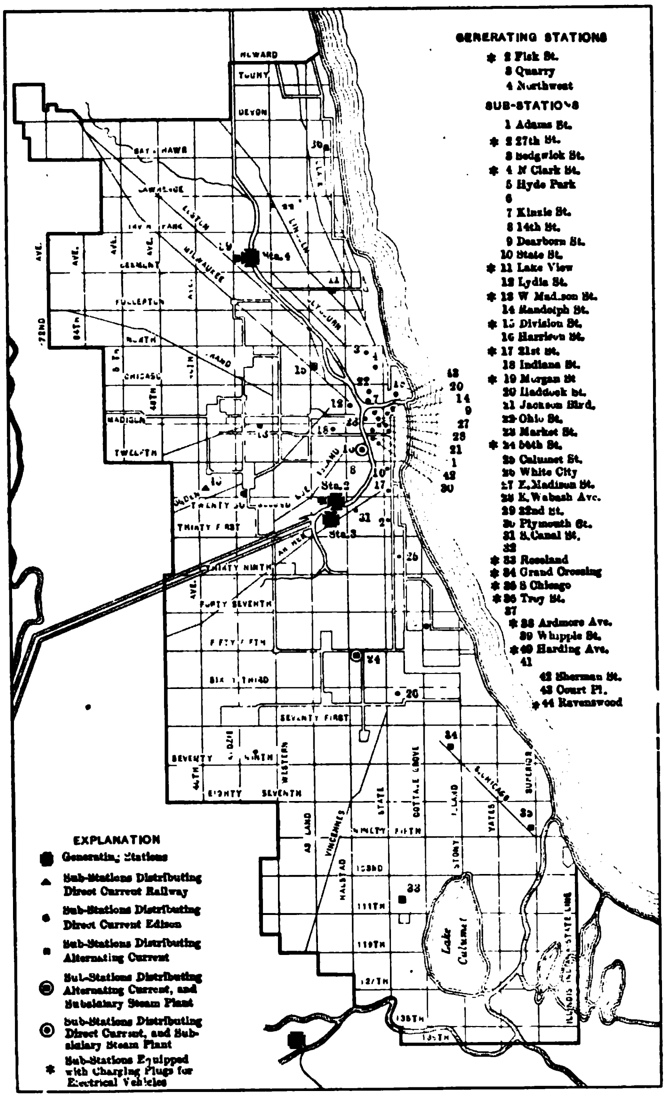
The total electric power generated in the State of Illinois is 400,000 kw., which is produced chiefly from coal, with the exception of 17 hydro-electric plants. The principal water-power property is that of the Mississippi River Power Co. at Keokuk, Ia., while other plants worthy of note are the Public Service Co.'s generating station at Joliet, and the Sanitary District plant at Lockport. The total potential waterpower of Illinois is 345,660 hp., which exists chiefly in the Mississippi and Ohio rivers. The development of this power would be expensive, the flat topography necessitating the condemnation of large farming areas or the construction of heavy dikes. Reference to the article on raw material resources elsewhere in this issue will show the nature of the coal supply, and this coal is proving a better source of power than water for the territory.

MISSISSIPPI RIVER POWER CO.

Standing out pre-eminent beyond all other developments in this district and remarkable among the world's hydro-electric plants, the 231,500-kw. generating station of the Mississippi River Power Co. at Keokuk, Iowa, is too well known to be described in detail in this article. The plant is located in a section where many raw materials are available for electrochemical reduction. The station contains thirty turbo-generator units with an overload capacity of 13,500 hp. per unit and transmissions are built as shown with the possibility of continual extension. Current is generated at 11,000 volts and transmitted at 110,000 volts. Of the total power generated 60,000 hp. is sold in St. Louis and a smaller amount to the smaller cities on the line. With 200,000 hp. now offered for sale there is still left a sufficient amount for large developments that may be desired.

In the construction of the dam and installation of the electric equipment, every imaginable contingency was considered, thus securing a reliable operation for many years to come. The dam proper, built out from the Illinois bluff, is of the gravity type and withstands all pressure upon it by virtue of bulk without bracing or reinforcement. The turbines and generators are specially designed by the best engineers available and are absolutely dependable as to operation.

The Mississippi River Power Co., with its plant on the Iowa side of the river at Keokuk, transmits energy into Illinois, after which the line follows the river to Hulls, Ill., where tap is taken off for a cement plant at Ilasco, Mo. Energy is then transmitted further down the river on the Illinois side, crossing just above St. Louis with the line supplying the city. Energy is also furnished to Alton, East St. Louis and Bellville, Illinois.


GENERATING STATIONS
* 2 Fisk St.
3 Quarry
4 Northwest
SUB-STATIONS
1 Adams St.
* 2 27th St.
3 Sedgwick St.
* 4 N Clark St.
5 Hyde Park
6
7 Kinzie St.
8 14th St.
9 Dearborn St.
10 State St.
* 11 Lake View
12 Lydia St.
* 13 W Madison St.
14 Randolph St.
* 15 Division St.
16 Harrison St.
* 17 21st St.
18 Indiana St.
* 19 Morgan St
20 Haddock St.
21 Jackson Blvd.
22 Ohio St.
23 Market St.
* 24 50th St.
25 Calumet St.
26 White City
27 E. Madison St.
28 E. Wabash Ave.
29 22nd St.
30 Plymouth Ct.
31 S. Canal St.
32
* 33 Roseland
* 34 Grand Crossing
* 35 S Chicago
* 36 Troy St.
37
* 38 Ardmore Ave.
39 Whipple St.
* 40 Harding Ave.
41
42 Sherman St.
43 Court Pl.
* 44 Ravenswood
EXPLANATION
● Generating Stations
▲ Sub-Stations Distributing Direct Current Railway
● Sub-Stations Distributing Direct Current Edison
■ Sub-Stations Distributing Alternating Current
◉ Sub-Stations Distributing Alternating Current, and Subsidiary Steam Plant
◎ Sub-Stations Distributing Direct Current, and Subsidiary Steam Plant
* Sub-Stations Equipped with Charging Plugs for Electrical Vehicles
Lake Calumet

GENERATING AND DISTRIBUTING POINTS, COMMONWEALTH EDISON CO.

The Alton substation is one of the distribution points for the high tension service as well as that from the local steam plant. Incoming 66,000-v. lines and the outgoing 13,200-v. lines terminate here. The outgoing 66,000-v. power is carried over steel towers to a substation in East St. Louis. This line is brought through the Alton substation so that all the 66,000-v. energy received from Keokuk may be measured. There are two 13,200-v. 25-cycle lines connecting Alton and East St. Louis substations, while two additional 13,200-v. lines supply local points. The operating statistics of the Alton substation should show a good comparison between production costs of steam power, generated locally, and hydro-electric power transmitted over long distances.

The Central Illinois Public Service Co. operates a 2500-kw. frequency changer set in the Mississippi River Power Co.'s power house at Keokuk, Ia., and through this unit energy is supplied to the system which stretches across the central portion of Illinois. The 25-cycle energy from the water-wheel generators is converted to 60-cycle 11,000-v. energy which is conducted through conduits in the dam to the Hamilton substation on the Illinois side, where it is stepped up to 33,000 v. for the transmission lines. The line from Hamilton to Colchester is the second link for Keokuk power to the Central Illinois Public Service Co. This development releases 2000 tons of coal per month for use at other steam plants. It is stated that the operating expense is not reduced by the new supply, but additional capacity is secured and reliability of operation effected.

OTHER WATER POWERS

The Public Service Co. generates a total of 5778 kw. by water power, with its principal plant located at Joliet. This plant generates a total of 3600 kw. and is connected to a part of the company's transmission system. The property as a whole depends upon steam plants, however. The Sanitary District of Chicago receives power from its 35,000-hp. hydro-electric plant at Lockport. This power is consumed principally for street lighting within the District and has recently been increased by the completion of an auxiliary steam plant, 4000-kw. capacity, located at the terminal station, West 31st Street and Western Avenue, Chicago.

STEAM PLANTS

The Commonwealth Edison Co. of Chicago, by virtue of territory served, is the largest steam generating system in the State. The accompanying outline map shows location of generating and distributing points.

The following table shows the statistics in percentages of the connected loads of the plants of other companies within the Chicago territory as compared with the Commonwealth Edison Co.:

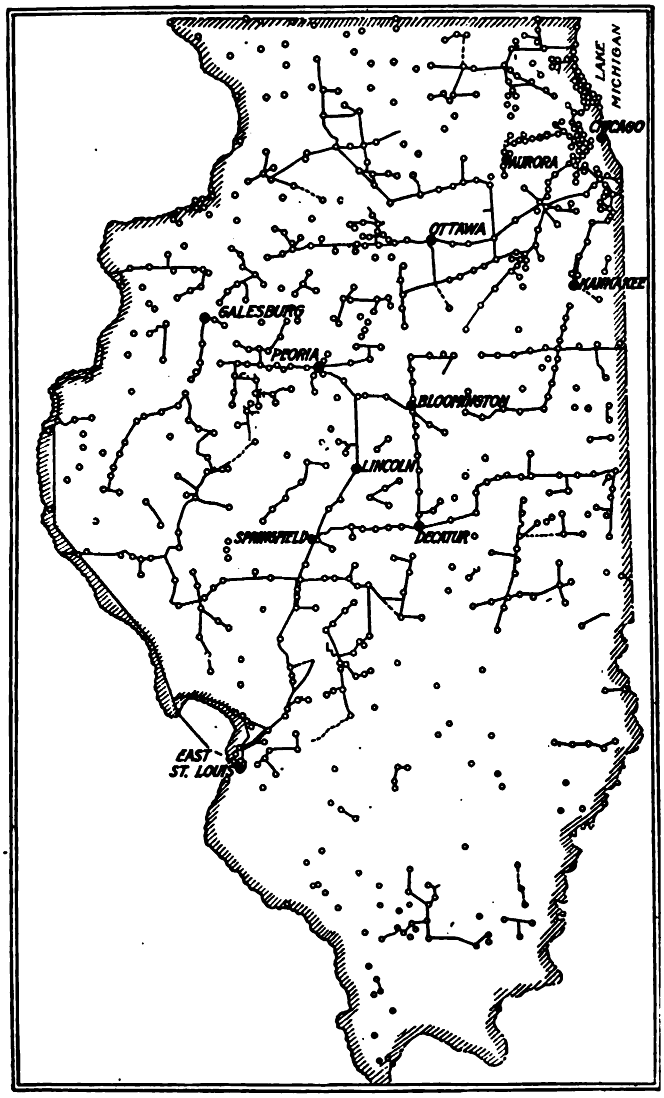
Company	Lamps		Motor Horsepower Per Cent
	Incandescent, Per Cent	Arc, Per Cent	
Commonwealth Edison Co.	95	96	89
Other companies	5	4	11

The generating equipment is located in three principal power plants. The downtown and southern end of the city is served from the Fisk and Quarry street stations with a combined rating of over 200,000 kw., while the northern section is served from the Northwest station. The distribution of load between stations is handled from the load dispatcher's office. Every facility for securing information in the shortest possible time is placed in the hands of this dispatcher. Maps, private telephone system, etc., are available for any emergency situation.

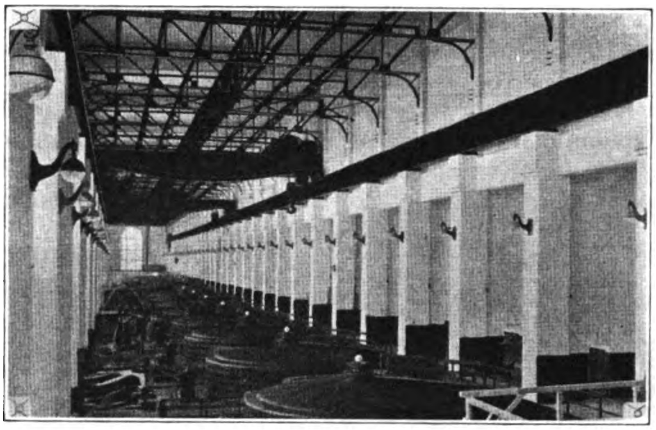
One of the features influencing the sale of power to chemical and electrochemical industries is the lower selling rate quoted for use of current during periods of the off-peak loads. In order to make the demand on the generating plants as uniform as possible the company may offer the use of power at certain times of the day at such a price per kilowatt-hour as to permit its economical employment in some of the chemical or metallurgical processes. This should apply to chlorine, and oxygen manufacture, where the operation may be intermittent.

INTERCONNECTING TRANSMISSION LINES

Supplementary to the general hydro-electric map appearing on page 341 the outline sketch herewith shows transmission lines owned by 28 companies in this locality. A considerable number of these companies are already interconnected for service interchange. There are also several connections between systems in Illinois and those in neighboring States. The Central Illinois Utilities Co. has a connection with the system of the Interstate Public Utilities Co. of Indiana. This connection, it is understood, is used only for emergency purposes on account of the difference in load characteristics of the two systems.



INTERCONNECTED TRANSMISSION LINES OF ILLINOIS



GENERATOR ROOM, KEOKUK, IOWA

The East St. Louis Light & Power Co. has connection with the Union Electric Light & Power Co. of St. Louis by means of submarine cable under the Mississippi River. The contract covering this service was recently authorized by the Illinois Public Utilities Commission. The cable is now in use and is mainly for the purpose of supplying emergency and peak service to East St. Louis.

The larger companies operating in Illinois besides those mentioned are the Illinois Traction System, covering a large district in central Illinois; the Middle West Utilities Co., composed of a number of smaller plants, in the sparsely settled districts throughout the State; the Public Service Co. of northern Illinois, and the Southern Illinois Light & Power Co.

Indiana

The flat topography of Indiana does not lend itself to any considerable water-power development, so the State must depend upon its large coal supply for power. The total installed generating capacity is 320,000 kw., being steam units with few exceptions. A water survey of the State shows power available for hydro-electric development as 126,000 hp., considerable part of which lies along the drainage area of the Wabash and Ohio rivers. The steam plants of the State are interconnected by adequate transmission systems radiating from Indianapolis.

The total number of steam properties within the State is 185, as compared with 224 in Illinois. The principal companies operating these former properties are: The Union Traction Co. of Indiana, the Indiana General Service Co., Interstate Public Service Co., Ft. Wayne & Northern Indiana Traction Co., Northern Indiana Gas & Electric Co., Indianapolis Light, Heat & Power Co., Indiana Railways & Light Co., Terre Haute Traction & Light Co.

One of the large manufacturing districts is served by the Northern Indiana Gas & Electric Co. at Michigan City, Hammond and East Chicago.

The one hydro-electric system of importance in the State is the property of the Indiana & Michigan Electric Co., with dams located at Elkhart, Ind., Berrien Springs and Buchanan, Mich. The transmission line serves South Bend, Michigan City and intermediate substations. The system is also supplied with power from steam plants at South Bend and Elkhart. Total water-power capacity is 20,000 hp. installed.

The Need for Research in the Non-Metallic Mineral Field*

Economic Importance of the Industry of Inorganic Non-Metallic Minerals — Need of Investigations and Engineering Studies on Their Value and Adaptability to Other Industries—Influence of the Non-Metallics Upon the Daily Life of a Community

By RAYMOND B. LADOO†

INDUSTRIAL problems brought out by the war and by the reversion from war to peace conditions have made necessary many changes of practice and methods which will result in the conservation of material resources, energy, efficiency and man power. Research is always necessary, but to-day it is particularly important. But our programs of research also need revision. In the mining and mineral industries a survey of the whole field is necessary to determine what fields have been covered, what fields should be covered, and what are the present problems in such fields.

All mining and metallurgical industries can be divided into three well defined groups: (1), the metal and alloy group; (2), the organic non-metallic group; and (3), the inorganic non-metallic group. The first group comprises the major and minor metals and their alloys. The organic non-metallic group includes coal, lignite, peat, petroleum, natural gas and other natural fuels. While it may be questionable if petroleum is of organic origin, for the purposes of research and investigation it logically falls within this group. The inorganic non-metallic group includes granite, sandstone, limestone, marble, slate and other structural stones; sand and gravel; limestone, dolomite, fluorspar and other fluxing stone; cement; clays and clay products; glass sand and glass; feldspar, flint, and other ceramic materials; salt and salines; phosphate rock, potash salts and other fertilizer materials; emery, corundum and other abrasives; magnesite; asbestos; mica; chalk, bauxite; talc and soapstone; gypsum; fuller's earth; graphite, etc.

GENERAL VIEW OF ELMHURST-CHICAGO STONE CO. QUARRY, ELMHURST, ILL.

Research in the metal group has been important for several decades. The need for research in the organic non-metallic group has been emphasized during the war and, while much work remains to be done, this field is now receiving much attention. The inorganic non-metallic group, however, has received but comparatively little attention by mining and metallurgical engineers. The economic importance of this group is great, and it is worthy of careful study.

Most of the minerals of this group are used as mined with but little modification, and their physical properties are preserved without change. Noteworthy exceptions to this are the manufacture of glass from glass sand, and cement from limestone and clay or shale. In the latter industries, the manufacture of glass and cement corresponds to the smelting or other metallurgical treatment of the metals. But in most instances the value or suitability of a non-metallic mineral depends upon preserving intact, in the finished products, its original physical and chemical characteristics. Thus the fibrous structure of asbestos, the platy structure of mica and the soft, white, greasy characteristics of talc are essential to their use.

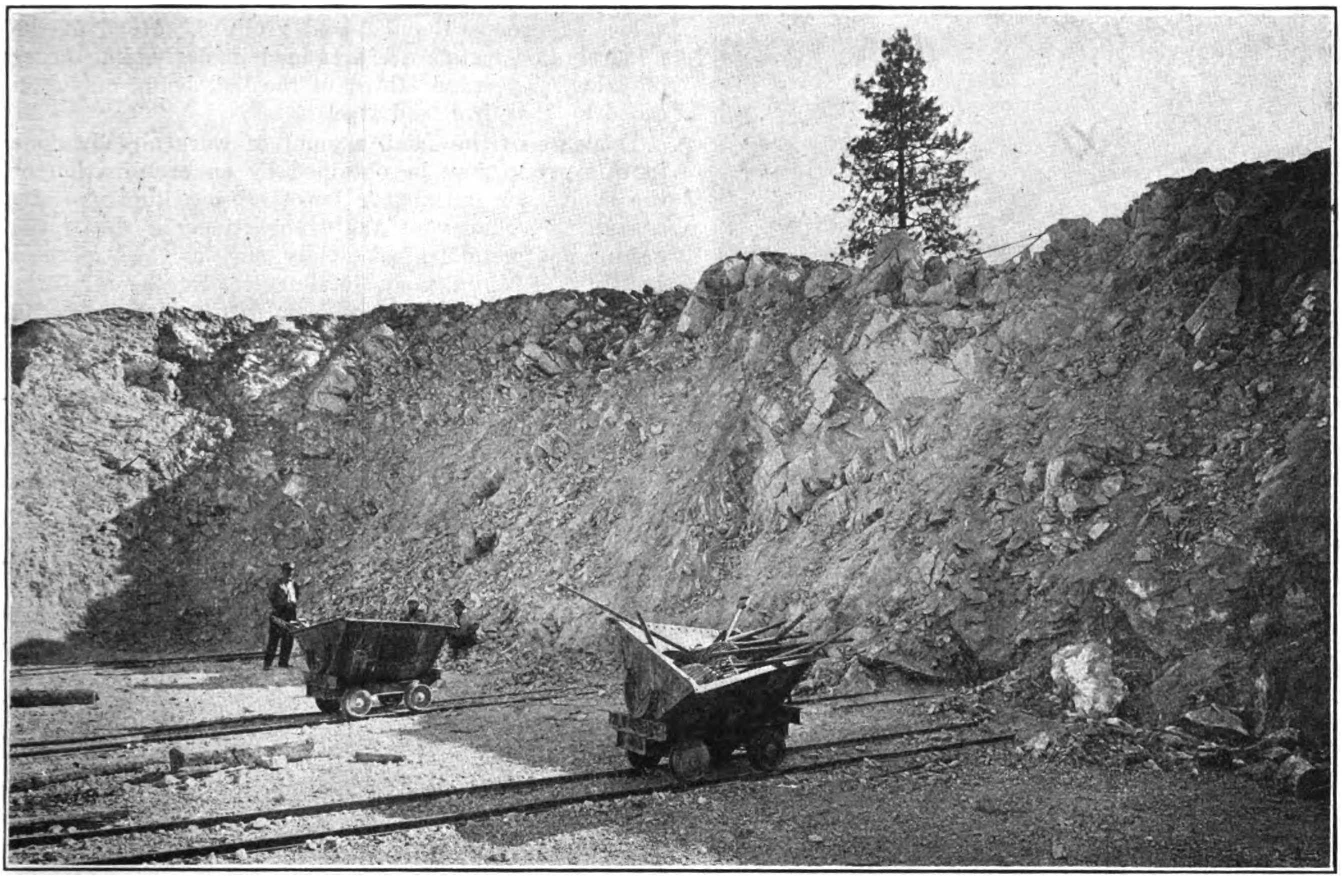
IMPORTANCE OF GROUP NOT GENERALLY RECOGNIZED

The importance of this non-metallic group and its proper place in mining investigation and literature have not been generally recognized. Quarrying is really but a special form of open-pit mining. Moreover, many non-metallic minerals are produced by underground mining methods. Methods of milling are strictly comparable with those used in the treatment of the metallic ores, and the "metallurgy" of such non-metals as glass sand and cement materials makes use of machinery, furnaces and methods similar to those used in true metallurgy. The largest screening and milling plants in the world are to be found in the sand, gravel and crushed rock industries. The largest gyratory crusher ever built has recently been installed at a limestone plant in Michigan, and likewise one of the largest, if not the largest, washing plant in the world is in operation in Michigan, washing limestone used as fluxing stone in the smelting of iron in the blast-furnace.

There are probably several reasons for this comparative oblivion. The intrinsic value of the crude materials in the ground is often low in comparison to that of the metals. Such materials as clay, sand, limestone and soapstone do not appeal to the average miner or prospector as do the metals. They are not surrounded with the glamour and romance that has made the search for the metals full of interest since prehistoric times. Another reason is that the value of many non-metallics depends largely upon collateral conditions, such as local demand, proximity of markets, freight rates, size and availability of deposits, rather than on intrinsic value. Copper or silver ores have a definite value depending upon their metal content, and the prospector does not have to consider how to market his product. Clay, talc, limestone and mica require a knowledge of market possibilities, and thus the needs for definite knowledge and engineering and business ability are even greater. The winning of most non-metallics has seemed easy compared to that of metals; and consequently little atten-

---

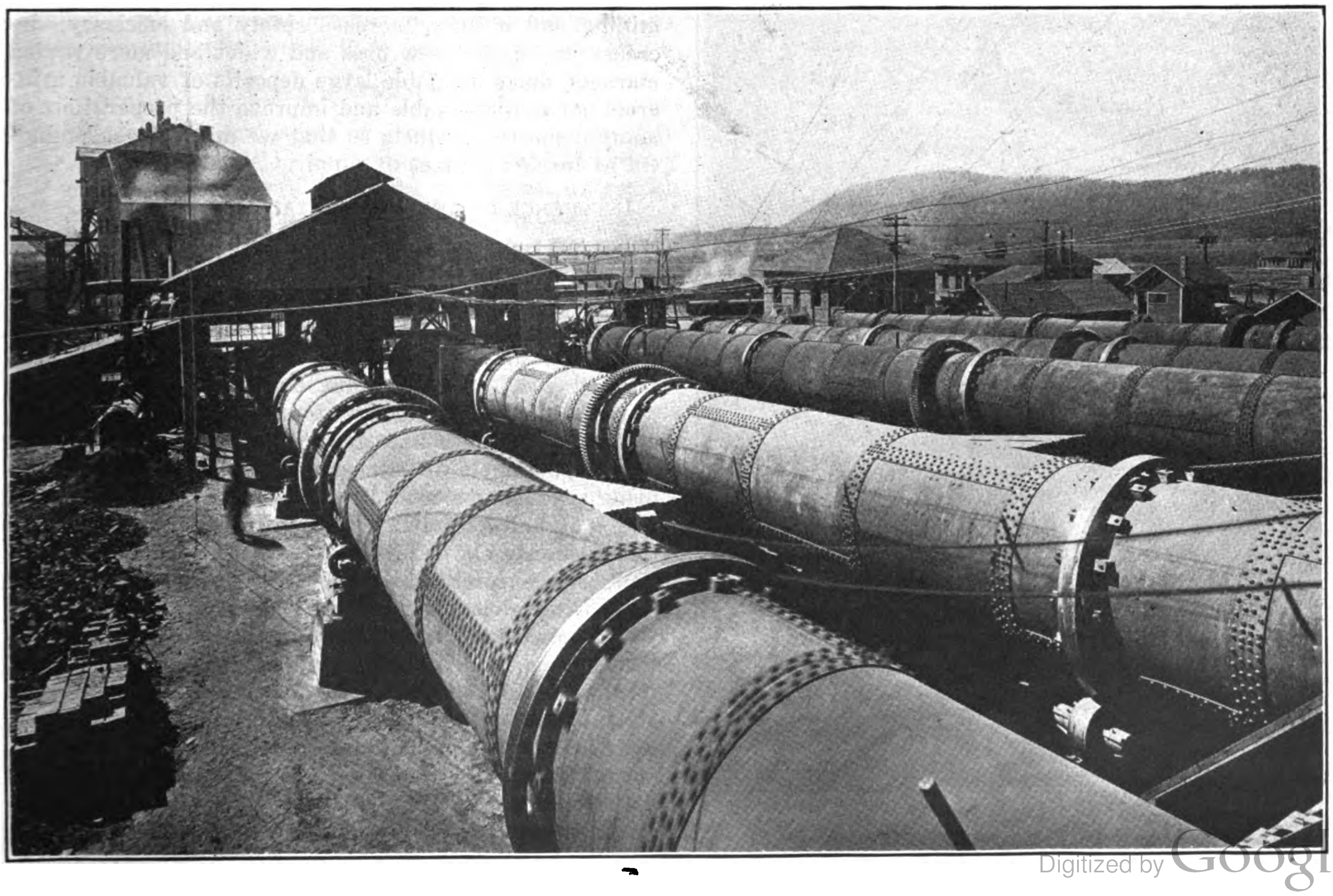
*Published by permission of the Director of the Bureau of Mines.
†Mineral Technologist, Bureau of Mines.

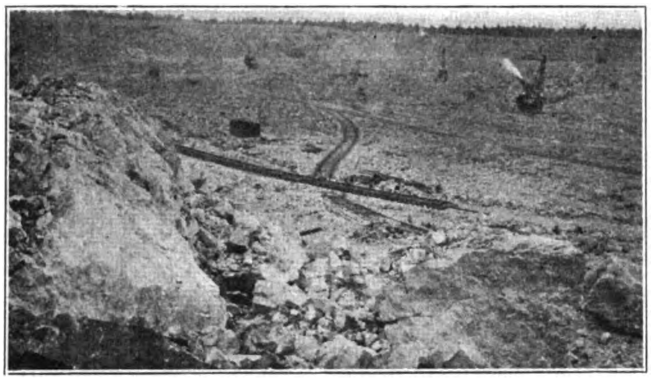


FACE OF QUARRY, MAGNESITE MINE

Northwest Magnesite Co., Chewelah, Wash.

ROTARY (CALCINING) KILNS AT REDUCTION PLANT





GENERAL VIEW OF HURON PORTLAND CEMENT CO. QUARRY, ALPENA, MICH.

tion has been paid to these subjects by the engineer. In the past many non-metallic mines and quarries have been started and run in a small, inefficient way by farmers or others as a side line. They have not, as a rule, until recently been considered as engineering problems of a magnitude comparable with metal mining operations, or as business propositions.

Economic Importance of This Mineral Group

That this mineral group is of great economic importance is shown by the following statistics compiled for the year 1916 by the U. S. Geological Survey in which the figures have been changed to round numbers. The total value of all mineral commodities was about $3,500,000,000. The combined value of groups 1 and 2, or the metal group and the organic non-metallic group, was about $3,000,000,000, while the value of group 3, the inorganic non-metallic group, was about $500,000,000. Thus there was a ratio of 6 to 1 between the combined values of groups 1 and 2 and group 3. If all of the minerals and metals are arranged in descending order of value, clay stands third in the list, being only preceded by coal, iron and steel.

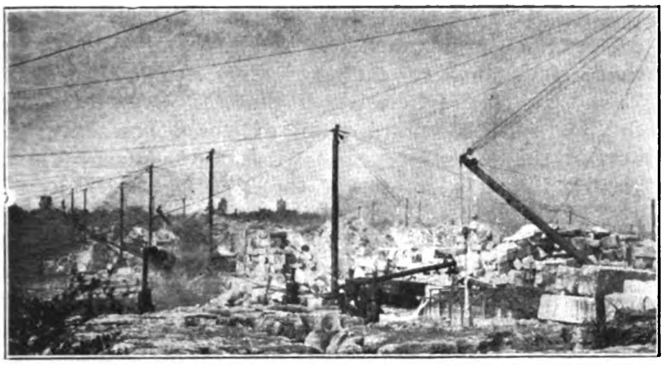
METHOD OF MOVING A CHANNELING MACHINE WITH A DERRICK, BEDFORD, IND.

Evidence of the small amount of work already done in this group may be obtained by an examination of the shelves or index of a large mining library or by consulting volumes of the transactions of any large mining and metallurgical society, such as the American Institute of Mining and Metallurgical Engineers. It is safe to say that there are at least fifty volumes relating to the metallics to one relating to the non-metallics. It is probable that, taking all mining and mineral literature, research and investigations together, this discrepancy would be far greater. There are a hundred consulting engineers in the one group to one in the other. Our technical mining and metallurgical societies contain few members interested primarily in the non-metallics, and their publications contain very few references to technical work in this group. Research and investigation in this group would improve methods of mining and milling, increase safety and efficiency, decrease waste, find new uses and wider and more varied markets, make available large deposits of valuable minerals not now workable and improve the preparation of many domestic products so that we might be independent of foreign sources of supply.

ANOTHER VIEW OF HURON PORTLAND CEMENT CO. QUARRY, ALPENA, MICH.

Influence of the Non-Metallics on Daily Life

Let us consider for a moment the influence of the non-metallics upon the daily life of the community. All large buildings are preponderantly non-metallic. They are built of stone or brick, tile, terra-cotta or concrete. Highways are stone, brick, concrete or asphalt and crushed rock. Large dams, dry docks, piers, breakwaters, bridges or bridge foundations, fortifications, subways and lighthouses are all built wholly or in major part of non-metallic mineral products. Water-distributing systems use concrete in the construction of dams, and sand and gravel in filtration plants; sewerage systems use clay sewer pipe. Metallurgical industries use limestone, dolomite and fluorspar fluxes; silica, clay, magnesite, dolomite, chromite and graphite refractories; abrasives, minerals, pigments, molding and filtering sand, and asbestos, and magnesite heat insulations. In almost every home are tiled bath rooms with their sanitary porcelain fixtures, living rooms with their marble or tile mantels, and tile, brick or stone fireplaces, glass mirrors, windows, lighting fixtures and glass-protected pictures, dining rooms with all their china, porcelain and glassware, the enamel on cooking



GENERAL VIEW OF THE BEDFORD, IND., LIMESTONE QUARRIES

utensils and sinks, asbestos mats, mica lamp chimneys and mica insulations in electric flatirons, basements with concrete floors, with their furnaces and pipes protected by asbestos and magnesia pipe-coverings and cements, and laundries with soapstone sinks and tubs. There is not a phase of our everyday life that is not touched directly or indirectly by the non-metallic minerals. Even the newspapers and magazines which we read use clay, talc, gypsum, chalk or other minerals as fillers and coatings. Rubber automobile tires contain talc, clay, magnesite or chalk as a filler; brake linings are of asbestos.

The importance of many of these things is often unrealized until supplies are suddenly cut off. During the war imports of Grecian and Austrian magnesite, Ceylon and Madagascar graphite, Italian, French and German talc, English fuller's earth, English china clay, German potash salts and other vital mineral commodities were cut off entirely or greatly reduced. Immediately our industries felt the loss and our war activities would have been crippled seriously had not domestic sources been immediately developed and by research adapted to our needs. If we had not possessed large resources of common salt, our great production of chlorine and other asphyxiating gases would have been impossible.

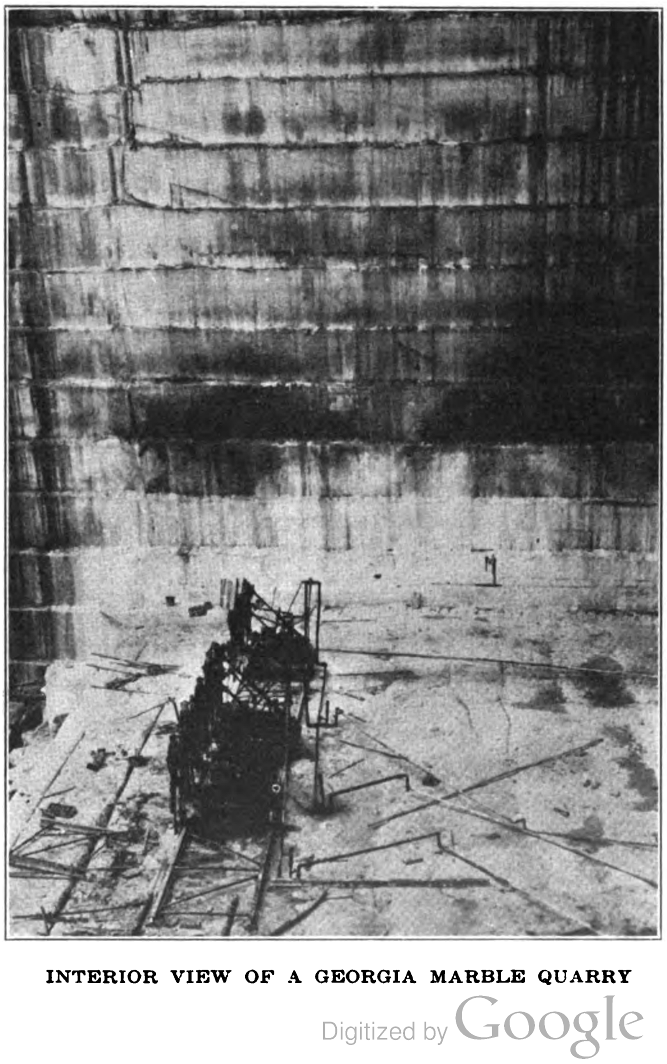
Field a Wide One

The problems and needs for research are as great in the non-metallic fields as in the metallic. Quarrying seems simple, but there is a large and almost untrodden field here for the application of modern engineering and mining principles. The methods of mining, milling and grading of talc and the mining, trimming and grading of mica offer fields for great improvement. It has been stated that domestic mica could fill all of the needs of this country, if properly trimmed and graded, yet over 60 per cent of the mica used in the country is imported. There are vast resources of high-grade clays in this country, but owing to improper methods of mining, washing, grading and blending, they are not considered satisfactory for our best porcelain and paper, and a very large amount of such clay is imported from England.

The chemical and physical properties of the metals have been accurately measured and standard tests of strength, composition and purity have been devised. Most metallic products are now purchased on specification, and checked up by standard tests. It is of interest to note that very few standard tests have been devised for the non-metallic minerals or their products, and few specifications are used in purchasing. Each producer makes certain grades which are in accord with his own ideas, but practically no two producers in certain industries offer the same or comparable grades. Consumers do not even know what grades are best suited to their needs. This creates confusion and dissatisfaction, and in the long run greatly injures the producer. For example, a papermaker may be induced to try talc as a substitute for English clay as a filler. The grade of talc which he tries may be totally unsuited to his uses and prove a failure. That papermaker then concludes that the use of talc in his paper is impossible and he condemns talc in general. A different grade of talc, intelligently selected from standard specifications, might have been found far superior to English clay. The lack of standardization of caustic magnesite for the plastic flooring industry has caused great dissatisfaction with California magnesite for this purpose. Doubtless this has been one of the factors in the lack of development of California magnesite for use in the flooring industry.

Our non-metallic minerals are more valuable than is ordinarily supposed. English china clay sells for over $30 per ton, Italian and French talc for $60 per ton, and asbestos No. 1 crude for over $1,500 per ton. Even fluxing limestone sold for $2.50 per ton or more in certain sections during the war. These values compared favorably with those of many of our metallic ores.

It has been argued that the mining problems in the non-metallics are the same as those in metallics, and that a consulting engineer experienced only in metallic ore mining can successfully enter the non-metallic field. So he can, if he is willing to make a detailed study of the new problems involved. But the non-metallic problems are usually very different from those in metallics.



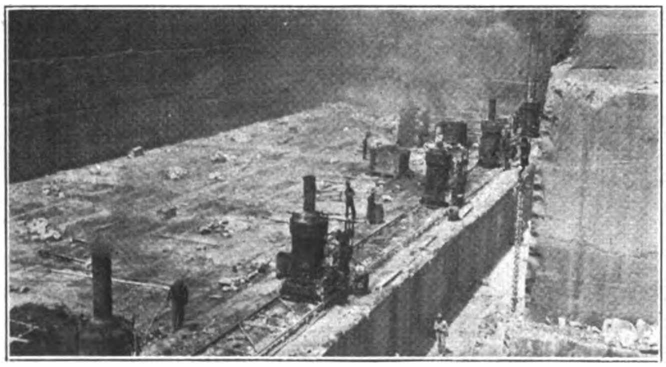
INTERIOR VIEW OF A GEORGIA MARBLE QUARRY

MILL NO. 3, EASTERN TALC CO., ROCHESTER, VT.

For example, in the quarrying of structural stone, the shape and size of the finished blocks are important. Fault and joint planes, color and grain, hardness and texture must be considered. The machinery involved is different. Few metal-mining engineers are familiar with the use of channeling machines or sawing, grinding and polishing machinery. In mining talc to be used for ground talc, grit must be excluded and iron-bearing surface water must not be allowed to discolor the talc. If the talc is to be sawed into crayons, or used for "lava" (baked talc used for gas burner tips and electrical insulation), it must be removed underground in large, sound blocks. In the milling of asbestos, the ore must not be left too long in a "breaker," or the fibers will be broken. In the mining of mica, large plates must not be broken by drilling or blasting. The white color of kaolin must not be spoiled by surface water or a mixture with iron-bearing clay or overburden. In preparing magnesite, care must be taken to exclude all dolomite or other lime-bearing carbonate.

In the underground mining of limestone, the value of the product is such that very little timbering can be afforded and methods of mining without timber must be used. Few metal-mining engineers appreciate the great difference between the two fields, and they are apt to minimize the essential distinctions, or to overlook the importance of this field entirely. These problems are often very difficult of solution, and call for the use of the best engineering skill, backed up by experience.

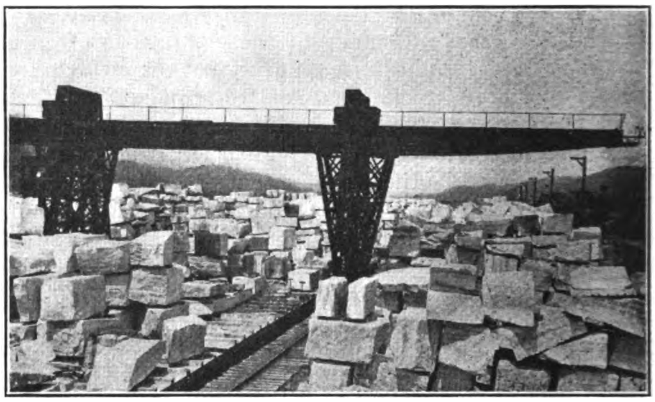
Another field of research in this group is that of determining accurately the physical and chemical properties of many minerals, looking toward the discovery of new uses. A good example of this is the mineral talc. Contrary to the impression which prevails in the minds of many, the principal use of talc is not for talcum powder, but as a filler for paper. Probably 80 per cent of the talc consumed in this country goes into the manufacture of paper. But there are many other important uses, among which are the roofing, paint and rubber industries, foundry facings, fillers for cotton cloth, "lava" gas tips and electric insulation. Over forty uses for talc are now known, many of which were developed during the last few years. But these uses could be greatly expanded if all of the chemical and physical properties of talc were studied and tabulated. For example, the colloidal properties of finely ground talc should be studied to determine further possibilities of talc as a lubricant in a water or oil suspension. The hardening of talc under heat is utilized in the manufacture of "lava," and research might extend this use. The presence of grit and dark color in some ground talcs is objectionable for many uses. These objectionable points might be eliminated by better methods of grinding and grading or by chemical treatment.



CHANNELING MACHINES AT WORK, BEDFORD, IND.

The subject of clay is one upon which much has been written, though there is little of permanent value. Of the best methods of mining and washing clays very little is known, and practically nothing has been published.

Within the last few years the producers of non-metallic minerals have begun to realize the importance of their industries and have awakened to the possibilities of expansion. Producers' associations have been formed with energetic technical and publicity committees. Advertising campaigns aimed to educate the public and popularize their products have been inaugurated, and as a result great progress has been made. Many persons who had never heard of magnesia a few years ago are now using magnesia pipe coverings in response to the slogan, "Let 85 per Cent Magnesia Defend Your Steam." A good beginning has been made and great expansion in this group of minerals seems inevitable.



TRAVELING CRANE AT VERMONT MARBLE CO. STOCK PILE, WEST RUTLAND

SUMMARY

1. The great economic importance of the inorganic non-metallic minerals cannot be denied.
2. Literature, research and investigations in this field have been very meager and unsatisfactory.
3. The intrinsic values of the individual minerals are large enough to attract the best engineering and business talent.
4. Mining and milling problems in the non-metallics are different from those in metallics and often are not appreciated by metal mining engineers.
5. A comparatively untrodden field lies open for consulting mining engineers and industrial chemists.
6. All present tendencies indicate a period of great expansion in this field in the near future.

Glucinum

An Introduction Intended to Encourage the Metallurgical and Chemical Development of the Industry of Glucinum, Its Alloys and Salts—Abundance of the Glucinum Minerals—Description of Some Relatively Successful Methods Employed for the Production of Glucinum Metal

BY J. S. NEGRU

THE minerals of glucinum have been, and to some extent still are, considered useful only as precious stones for ornamental purposes, but only an infinitesimal quantity of these minerals is found to be of sufficient purity and beauty of color to make them valuable as ornaments. The minerals of lower quality were, and still are, practically useless, and their mining is neglected. There is an abundance of glucinum minerals in the United States and elsewhere, some of them in crystals weighing about 60 lb. (gadolinite, Texas) and even about 2900 lb. (beryl, New Hampshire). According to J. H. L. Vogt[1] between 0.01 per cent and 0.001 per cent of the entire earth's crust is glucinum. The progress realized in industrial chemistry has opened new aspects as to the value of these minerals for their glucinum content.

VAUQUELIN FIRST TO DISCOVER EXISTENCE OF GLUCINUM

In 1797 the mineralogist Haüy, having found that the minerals beryl and emerald have the same physical structure, hardness and specific gravity, entrusted L. N. Vauquelin with the work of determining whether these minerals were also of identical chemical composition. Vauquelin, besides proving that they are identical chemically, also discovered that they contain an oxide which until then was considered to be alumina, but which he separated from the alumina by the precipitation occurring when the caustic potash solution of the hydrates is concentrated by boiling. He studied this new product and assigned to it many distinctive properties, of which the most characteristic are: Its salts are sweet and lightly astringent; soluble in dilute ammonium carbonate; insoluble in ammonia; does not form alums; absorbs ¼ of its weight of carbon dioxide; decomposes salts of alumina. He has given to the oxide a place between alumina and magnesia. Due to the fact that the salts of this new oxide are sweet, it was named glucina.[2]

Humphry Davy attempted to reduce glucina with potassium vapors, but without success. He then fused glucina with iron filings and potassium in a clay crucible, dissolved the fused mass in water and obtained a residue of a semi-malleable mass. This was in reality a glucinum-iron alloy.[3]

F. Wöhler in 1827 was the first to succeed in isolating glucinum metal. He worked on the chloride obtained by mixing glucinum hydroxide with carbon and heating the mixture to red heat in a current of chlorine gas. He placed in a platinum crucible a layer of potassium, then the glucinum chloride and then another layer of potassium, and heated to fusion. The fused mass was thrown into a beaker of water; the potassium salt formed was dissolved, and there was left a dark-gray residue which when washed, dried and burnished presented a metallic luster.[4] Bussy in France prepared a similar product almost simultaneously with Wöhler, and by the same method. The product was an impure glucinum. Subsequent work by others led to the separation of a 99.8 per cent pure glucinum.

Up to the present the only methods by which the metal is extracted from its minerals are based on the obtainment of its haloids directly or by subsequent treatments, and by reducing these haloids mainly with potassium or sodium, or by electrolyzing a solution of a double chloride, bromide or fluoride of glucinum. These methods, although already employed on a quasi-industrial scale, render the cost of glucinum quite prohibitive. The direct reduction of glucina has not yet been made on a practical scale, but when this is realized the special properties of the metal, combined with its reduced cost, will contribute to its becoming one of the most valuable metals in chemical and other industries.

USES OF GLUCINUM

Glucinum possesses properties which will make it useful for the manufacture of special electrical and other scientific instruments and apparatus; its organic and inorganic salts have, some at least, useful pharmaceutical properties; its alloys, especially the glucinum-copper alloys, are already known to possess important properties, and their more extensive use is only a matter of lower cost. The synthetic preparation of pure precious stones for ornamental purposes, some of which have already been produced, is another field for the industrial use of glucinum and its salts.

Glucinum Minerals

The metal glucinum is not found in a native state, but is present in a great number of granitic rocks in the form of aluminates, silicates, phophates, borates, etc. The minerals of glucinum which are already known to occur in the United States in quantities sufficient to permit their economic use are:

Bertrandite. A glucinum silicate of the composition $4GlO.2SiO_2.H_2O$ (50.3 per cent SiO_2, 42.1 per cent GlO, 7.6 per cent H_2O). It is found in Bohemia, France and in the United States (Colorado, Maine, Virginia). Colorado: Mount Antero, Chaffee County; Maine: Stoneham, Oxford County; Virginia: Amelia Court House, Amelia County.

Beryl. A glucinum-aluminum silicate of the composition $3GlO.Al_2O_3.6SiO_2$ (67 per cent SiO_2, 19 per cent Al_2O_3, 14 per cent GlO). It is found in Austria, Bohemia, Brazil, Colombia, Cornwall, Island of Elba, Egypt, Finland, France, India, Ireland, Madagascar, New South Wales, Norway, Peru, Scotland, Siberia, Sweden and the United States (Alabama, California, Colorado, Connecticut, Georgia, Maine, Massachusetts, New Hampshire, New Mexico, North Carolina, Pennsylvania, South Carolina, South Dakota, Utah, Virginia).

---

[1] *Trans.*, Am. Inst. M. E., Vol. 31, p. 128, 1902.

[2] L. N. Vauquelin, *Ann. de Chimie et de Physique*, 1ère serie. T. 26 (1798), pp. 155-170; 170-179.

[3] Humphry Davy. *Philos. Mag.*, London, Vol. 32 (1808), pp. 152 and 203.

[4] F. Wöhler. *Ann. der Physik und Chemie* (Poggendorff), Vol. 13 (1828), pp. 577-582.

Alabama—Near Rockford and Hissop, Coosa County.

California—Riverside County: Coahuila and near Hemet; San Diego County: Pala, Rincon, Mesa Grande, Ramona, and in the Polomar Mts. 9 miles southeast of Pala; Tuolumne County: Jamestown.

Colorado—Boulder County: near Glendale; Chaffee County: near top of Mount Antero; Clear Creek County: Georgetown; Fremont County: at East Gulch, 6½ miles north of Texas Creek; Jefferson County: near Creswell; Park County: Buffalo Mt.

Connecticut—Fairfield County: Branchville; Litchfield County: 6½ miles north of New Milford; Middlesex County: Middletown, Portland, Chatham and Haddam; New Haven County: Southford Quarry.

Georgia—Rabun County: Beck Beryl Mines, 7 miles east of Clayton.

Maine—Kennebec County: Winslow; Oxford County: Albany, Newry, Paris, Greenwood, Stoneham, Peru, Hebron (Cæsium beryl), Buckfield (Cæsium beryl); Sagadohoc County: Topsham; Androscoggin County: Auburn, Poland (Cæeium beryl); Hancock County: Catharine Hill.

Massachusetts — Worcester County: Royalston; Franklin County: Northfield; Hampden County: Blandford; Hampshire County: Chesterfield, Goshen, Norwich.

New Hampshire — Cheshire County: Sullivan, Alstead, Roxbury; Grafton County: near Orange, near Grafton[5], Wentworth, Alexandria; Merrimack County: 2 miles west of Danbury; Sullivan County: near South Acworth.

New Mexico—Santa Fé County: near Santa Fé.

North Carolina—Alexander County: near Hiddenite; Burke County: near Burkmont; Jackson County: south of Cashiers; Macon County: at head of Tennessee Creek; Mitchell County: Wiseman and other mica mines; Yancey County: Ray and other mica mines.

Pennsylvania—Chester County: near Northrop and Unionville; Delaware County: Leiperville, Chester, near Media; Philadelphia County: Fairmont Park, Germantown, Logan, Mount Airy, Shawmont.

South Carolina—Anderson County: along the Anderson Spartanburg zone.

South Dakota—Custer County; Pennington County: near Keystone.

Utah—Tooele County: about 35 miles southwest of Simpson Springs, Ibapah Mountain.

Virginia—Amelia County: Amelia mica mine; Henry County: near Axton; Rockbridge County: in Irish Creek area.

Beryllonite. A sodium-glucinum phosphate of the composition $Na_2PO_4.Gl_2P_2O_8$ (55.9 per cent P_2O_5, 19.7 per cent GlO, 24.4 per cent Na_2O). It is found in the United States at Stoneham, Oxford County, Maine.

Chrysoberyl. A glucinum-aluminum oxide of the composition $GlO.Al_2O_3$ (80.2 per cent Al_2O_3, 19.8 per cent GlO). It is found in Brazil, Ceylon, Ireland, Moravia, Siberia and the United States (Colorado, Connecticut, Maine, New Hampshire and New York).

Colorado—6 miles west of Sedalia, Fremont County.

Connecticut—Haddam, Middlesex County.

Maine—Newry and Stoneham, Oxford County.

New Hampshire—New Orange Summit, Grafton County.

New York—Greenfield, Saratoga County.

Danalite—A complex mineral of the composition $(Gl,Fe,Zn,Mn)_7Si_3O_{12}S$ with about 14 per cent GlO. It is found in the United States (Colorado, Massachusetts, New Hampshire).

Colorado—West Cheyenne Canyon, El Paso County.

Massachusetts—Essex County: Rockport, Cape Ann, Gloucester.

New Hampshire—Bartlett.

Gadolinite. A complex silicate of glucinum, iron and yttrium, of the composition $2GlO.FeO.2Y_2O_3.2SiO_2$ (23.9 per cent SiO_2, 51.8 per cent Y_2O_3, 14.3 per cent FeO, 10 per cent GlO). It is found in Greenland, Ireland, Norway, Silesia, Sweden and the United States (Arizona, Colorado, Texas).

Arizona—Mohave County: In cliffs, 30 miles south of Hackberry, and near Kingman, about 6 miles west of Chin Lee Valley and 2 to 4 miles south of the Utah line.

Colorado—Douglas County: Devil's Head Mountain; Washington County: Akron.

Texas—Burnett County; Llano County: Baringer Hill.[6]

Helvite. A complex silicate of the composition $(Mn,Fe)S.3(Gl,Mn,Fe)_2SiO_4$, with about 13.5 per cent GlO. It is found in Finland, Hungary, Norway, Saxony and the United States (near Amelia Court House, Amelia County, Virginia).

Herderite. A fluophosphate of calcium and glucinum of the composition $(CaF)GlPO_4$ (43.8 per cent P_2O_5, 15.4 per cent GlO, 34.6 per cent CaO, 5.9 per cent F). It is found in Saxony and the United States (Maine: Hebron and Stoneham[7], Oxford County, and Auburn, Androscoggin County).

Phenacite. A glucinum orthosilicate of the composition $2GlO.SiO_2$ (54.45 per cent SiO_2, 45.55 per cent GlO). It is found in the Urals (near Ekaterinsburg), France, Mexico (near Durango), Switzerland and the United States (Colorado, Maine, Virginia).

Colorado—Chaffee County: Mount Antero and Devil's Head; El Paso County: Crystal Park, 2 miles southwest of Manitou; Teller County: Topaz, Butte, near Florissant, and at Cripple Creek in the Gold King Mine.

Maine—Near Stoneham, Oxford County.

Virginia—Amelia Court House, Amelia County.

Other important glucinum minerals, which have not yet been located in the United States, are:

Euclase. A glucinum-aluminum silicate of the composition $2GlO.2SiO_2.Al_2O_3.H_2O$ (41.3 per cent SiO_2, 35.2 per cent Al_2O_3, 17.3 per cent GlO, 6.2 per cent H_2O). It is found in Brazil (Province of Minas Ceraes), Ural (Orenburg District) and in the Austrian Alps.

Eudidymite. A glucinum-sodium silicate of the composition $H_2O.Na_2O.2GlO.6SiO_2$ (73.4 per cent SiO_2, 10.2 per cent GlO, 12.7 per cent Na_2O, 3.7 per cent H_2O). It is found in southern Norway, near Langesund fiord.

---

[5] Here are found crystals of beryl weighing up to 2900 lb.

[6] Here are found crystals of gadolinite weighing up to 60 lb.

[7] The Stoneham mineral is also called glucinite.

Hambergite. A glucinum borate of the composition $4GlO.B_2O_3.H_2O$ (53.25 per cent GlO, 36.72 per cent B_2O_3, 10.03 per cent H_2O). It is found in southern Norway, near Langesund fiord.

Leucophane. A complex silicate of the composition $NaF.3GlO.3CaO.5SiO_2$ with 10.3 per cent GlO. It is found in the southern part of Norway, near Langesund fiord.

Meliphanite. A complex silicate, somewhat similar to leucophane, of the composition $NaF.2GlO.2CaO.3SiO_2$ with 13.1 per cent GlO. It is found in Norway, near Langesund fiord.

Trimerite. A complex silicate of the composition $(Mn,Ca)_2SiO_4.Gl_2SiO_4$ with 16.6 per cent GlO. It is found in Sweden, at Vermland.

Glucinum is also found in some natural waters, monazite sand, and some aluminous schists.

Treatment of Glucinum Minerals for Glucina

METHOD OF VAUQUELIN[8]

The mineral (beryl) is crushed and heated. The cooled mass is pulverized and mixed intimately with 3 parts of its weight of caustic potash, and the mixture is fused. The mass obtained is cooled and dissolved in water; filter to separate the silica. The filtrate is treated with an excess of caustic potash solution and boiled until a precipitate is obtained which contains the hydroxides of all the glucinum and some of aluminum. The precipitate is filtered off and dissolved with hydrochloric acid and reprecipitated with potassium carbonate. This precipitate is filtered off and dissolved with sulphuric acid, and potash is added to the solution, when aluminum separates in the form of crystallized alum. Filter. The filtrate, which has a very sweet taste, is diluted with water and an excess of ammonium carbonate is added. Only the glucinum salt remains in solution. Filter. The filtrate is concentrated by boiling until a precipitate is obtained, which is washed and dried, yielding basic glucinum carbonate. This when calcined yields glucina (GlO).

METHOD OF DEBRAY[9]

The mineral (beryl) is pulverized and mixed with half its weight of powdered quicklime. The mixture is fused in clay crucibles. The glass obtained is powdered and treated first with dilute nitric acid, then with concentrated nitric acid, with continuous agitation till it is reduced to a homogeneous jelly. This is evaporated to dryness and calcined sufficiently to decompose the nitrates of aluminum, glucinum, iron and also a small portion of the nitrate of calcium. The residue, which consists of silica, alumina, glucina, iron sesquioxide, calcium nitrate and a little lime, is boiled with an ammonium chloride solution, when the calcium nitrate and the lime are dissolved with evolution of ammonia. (If there is no evolution of ammonia it indicates that the calcining has not been carried out sufficiently, when it is necessary to calcine again and re-treat as above.) Filter. Pour the filtrate into an excess of an ammoniacal solution of ammonium carbonate. Allow to stand for 8 days, when all the glucinum and a small amount of iron salts are dissolved. Add a little ammonium sulphide to precipitate the iron completely. Filter. The filtrate contains only the glucinum salt. Concentrate the solution by boiling, when the ammonium carbonate is decomposed with the formation of a basic glucinum carbonate which separates as a white powder precipitate. Filter. This precipitate washed, dried and calcined yields glucina.

METHOD OF SCHEFFER[10]

This method is based on the fact that when metallic zinc is introduced into a solution of aluminum sulphate, zinc sulphate is formed along with basic sulphate of aluminum which precipitates. This precipitation is complete in a dilute solution. The glucinum sulphate treated in an analogous manner is decomposed with the formation of dibasic sulphate which remains completely dissolved.

The mineral (beryl) is powdered and mixed with fluorspar. The mixture is digested with sulphuric acid at a gentle heat (about 200 deg. C.) and ultimately heated to dull red to expel the silicon fluoride and the excess of sulphuric acid. The residue is dissolved in water acidulated with sulphuric acid. In order to remove the greater part of aluminum add to the solution potassium sulphate or ammonium sulphate, thus forming alums which crystallize out. Filter. The filtrate is greatly diluted, and metallic zinc is added. Allow to stand 2 to 3 days. Heat and filter. To the filtrate add a quantity of potassium sulphate proportional to the amount of zinc used (1.4 parts K_2SO_4 for 1 part Zn) to form with the sulphate of zinc a double salt which crystallizes out. To remove the rest of the zinc add to the solution an excess of sodium acetate and pass a current of hydrogen sulphide. Filter. The filtrate is treated with ammonia and ammonium sulphide to remove the iron. Filter, and neutralize the filtrate with ammonia and add an excess of ammonium carbonate. Filter and concentrate by boiling, when a precipitate will be obtained. Filter. The residue washed and dried yields the basic glucinum carbonate. This when calcined yields glucina (GlO).

METHOD OF GIBSON[11]

This method is based on the principle that ammonium-hydrogen fluoride effects the complete decomposition of beryl at a relatively low temperature, even when the mineral is only coarsely powdered. The crude ammonium-hydrogen fluoride employed is prepared by neutralizing commercial hydrofluoric acid in a leaden vessel with ammonium carbonate, then a quantity of hydrofluoric acid equal to the quantity taken in the first place is added, the solution concentrated by boiling, and on cooling the double fluoride crystallizes out.

The mineral (beryl) is coarsely ground and mixed thoroughly in a large iron pot with 6 parts of ammonium-hydrogen fluoride. The mixture is liquefied and boiled with continuous stirring until it becomes a thick mass and dense white fumes (ammonium fluosilicate) are given off. The mass is cooled, powdered roughly, boiled with water for several hours, allowed to settle and filtered. The residue is re-treated as above and filtered. Combine the filtrates, and then evaporate to dryness. The fluorides are converted into sulphates, by treating with concentrated sulphuric acid. Heat until a partial decomposition of the sulphates has taken place. Digest with water and filter. Add to the filtrate nitric acid to oxidize the iron and pour the solution in small portions at a time into an excess of ammonium sesquicarbonate with frequent agitation. The aluminum salt and the bulk of the iron are precipitated and only the glucinum salt and a small quantity of iron remain in solution. Filter. To remove the last traces of iron from the filtrate add mercuric chloride and ammonium sulphide and filter. The filtrate is neutralized with ammonia and treated with an excess of ammonium carbonate. Only the glucinum salt remains in solution. (If some mercury passes over it will be eliminated in the subsequent calcining.) Filter. The filtrate is boiled until basic glucinum carbonate separates out, which is washed, dried, and ignited to yield glucina (GlO).

---

[8] L. N. Vauquelin. *Annales de Chimie.* T. 26 (1798), pp. 259-265.

[9] Henri Debray. *Annales de Chimie et de Physique,* 3ème serie, T. 44 (1855), pp. 5-41.

[10] G. Scheffer. *Annalen der Chcmie und Pharmacie,* Vol. 33 (1859), pp. 144-147.

[11] John Gibson. *Journal* of the Chem. Soc., London, Vol. 63 (1893), pp. 909-922.

Methods of Lebeau[12]

The mineral (beryl) is mixed with two parts of calcium fluoride, and the mixture fused in a graphite crucible. The fused mass is poured into water, thus yielding a porous material which is easily pulverized. The powder is placed in a stoneware vessel and attacked with sulphuric acid in the cold, avoiding excessive heat. Silicon fluoride escapes. When this reaction is complete, heat on a sand bath until white fumes of sulphuric acid appear. Now throw the mass by small portions into water, when the sulphates of aluminum, glucinum and iron are dissolved, and there remains a deposit of calcium sulphate. Decant. The precipitate is washed and filtered and the solutions are concentrated. The excess of acid is then partially saturated with potassium carbonate, and the liquid is allowed to cool, when the greatest part of the aluminum separates in the form of alum. Filter. The filtrate is saturated with ammonia with the further addition of an excess of ammonium carbonate. Allow to stand for a few days with frequent stirring. Filter. The filtrate on ebullition deposits an impure glucinum-ammonium carbonate. Filter. The residue is redissolved in nitric acid. Dilute, and add a little potassium ferrocyanide, which throws down all the iron. Filter. (The last precipitation is avoided if instead of potassium ferrocyanide ammonium ferrocyanide is used and the iron separated by H_2S.) The filtrate free of iron is treated with ammonia; leave stand 3 or 4 days; the supernatant liquor is decanted and replaced by a concentrated solution of ammonium carbonate, which slowly dissolves the glucinum salt, leaving a slight white deposit of aluminum hydroxide. Filter. Boil the solution, the precipitate formed is carefully washed and dissolved in nitric acid. Evaporate to dryness and ignite. The product which is obtained is pure glucina (GlO).

Lebeau also used an electric furnace.[13] Instead of fusing a mixture of the mineral with calcium fluoride in an air furnace he melted and boiled the mineral (beryl) by the heat of an electric furnace. The finely powdered mineral is mixed with its own weight of clean coke. The mixture is heated in an electric furnace for 1½ hr. with a current of 1500 amp. Abundant vapors of pure silica are driven off, leaving a fused substance which consists of a mixture of aluminum carbide, glucinum carbide, iron silicide and carbon silicide. By subjecting the mass to weathering conditions it disintegrates. The disintegrated mass contains the aluminum and glucinum partly as hydrates and partly as carbides, which are easily attacked by acids. By using hydrofluoric acid and sulphuric acid the silica is expelled as silicon fluoride, and the residue, which consists of the sulphates of aluminum, glucinum and iron, is treated as above.

Method of Warren[14]

The mineral (beryl) is powdered and incorporated thoroughly with four times its weight of sodium carbonate. The mixture is fused for 3 hr. at the highest temperature of a powerful blast-furnace. Cool the melt, dissolve by supersaturated steam and an excess of hydrochloric acid. Evaporate to dryness, take up with water and filter off the silica. The filtrate is freed of its iron content and the precipitate is filtered off. The filtrate is rendered alkaline by means of an excess of sodium carbonate, and heated with an excess of gaseous sulphurous acid in which both the alumina and glucina dissolve. The solution is heated to boiling, when aluminum hydroxide is precipitated in a granular form instead of the tedious gelatinous deposit obtained when using ammonia. Filter. Add to the filtrate an excess of ammonium carbonate. The solution is concentrated by boiling, when basic glucinum carbonate separates out as a white granular powder. Filter the residue, wash, dry and calcine for glucina, or keep as carbonate for further treatment. (See page 358.)

Method of Wyrouboff[15]

In examining various compounds of glucinum, Wyrouboff has found that the oxalate $2GlC_2O_4.3K_2C_2O_4$ is only sparingly soluble; thus at 15 deg. C. 100 parts of water dissolve only 1.4 parts, and the solubility does not increase appreciably with the temperature, whereas at the same temperature the oxalates of aluminum, iron and chromium are completely soluble in only 2 to 3 parts by weight of water. He has made use of this property for a process to treat glucinum minerals for glucina.

The mineral is attacked with potassium hydrate, the silica separated in the usual way, the solution of chlorides evaporated to a small volume and treated with a concentrated solution of potassium oxalate. After a short time of standing a crystalline precipitate of oxalates is formed. Decant. The residue is treated with a small quantity of water, when only the glucinum salt remains undissolved. Filter the residues, dry and calcine to glucina, or preserve as oxalate and use as a starting product for other glucinum salts. To avoid the presence of acids during the operation, as the oxalate of glucinum is very soluble in dilute acids, it is best to neutralize the solution with an alkali after adding the potassium oxalate.

Methods of Pollok[16]

The mineral (beryl) is finely powdered and mixed with its own weight of caustic soda. The mixture is fused; the cooled mass is pulverized and treated with strong hydrochloric acid with constant stirring. The heat generated by the reaction brings the whole mass to the boiling point without the necessity of external heat. Allow to settle for one day. Decant, add more hydrochloric acid and water, and boil with steam. Allow to settle, siphon the solution and throw the silica on a linen filter and wash. Treat the whole of the solution with ammonia, re-dissolve the precipitate with hydrochloric acid and saturate the solution with hydrochloric acid gas, thus precipitating nearly all the aluminum as chloride and leaving all the glucinum and iron in solution. Filter. Concentrate the filtrate by boiling until it becomes of syrupy consistency, and add it by small quantities at a time to a saturated solution of ammonium carbonate with repeated stirring. Only the glucinum salt and a little iron remain in solution. Treat with ammonium sulphide to separate the iron, allow to stand for 2 days and filter. The filtrate free of aluminum and iron is concentrated by boiling to about half its volume, when all the glucinum is precipitated in the form of basic glucinum carbonate, which when washed, dried and calcined yields glucina.

---

[12] P. Lebeau. *Comptes Rendus*, T. 121 (1895), pp. 641-644.

[13] P. Lebeau. *Comptes Rendus*, T. 126 (1898), pp. 1202-1205.

[14] H. N. Warren, *Chemical News*, Vol. 72 (1895), pp. 310-311.

[15] G. Wyrouboff. Bull. de la Soc. Chim. de Paris, 3ème serie, T. 27 (1902), pp. 733-734.

[16] J. H. Pollok, *Sci. Trans.* Roy. Dublin Soc., Series 2, Vol. 8 (1904), pp. 139-152.

By another method of Pollok the powdered mineral is mixed with caustic potash and fused. The cooled mass is pulverized and treated with dilute sulphuric acid and well boiled with steam. Filter to separate the silica. The filtrate is evaporated to the crystallizing point, allowed to cool and stand for one day. The alum crystals formed are drained off. Re-evaporate the filtrate and repeat the process until a portion of the mother liquor, when poured into an excess of ammonium carbonate, gives a precipitate that completely re-dissolves on shaking up. The whole of the liquors containing all the glucinum as sulphate and some impurities is poured by small quantities at a time into a saturated solution of ammonium carbonate with repeated stirring. Add ammonium sulphide to separate the iron. Filter. The filtrate containing only the glucinum salt is treated as in the first method.

By still another method of Pollok the powdered mineral is mixed with its own weight of caustic soda and fused. The cooled mass is pulverized, treated with dilute sulphuric acid and well boiled with steam. Filter to separate the silica. The filtrate is treated with ammonia, the precipitate is re-dissolved with sulphuric acid, and potassium sulphate is added to the solution. Evaporate down to the crystallizing point, and after most of the alum has crystallized out treat the solution with its own volume of alcohol, which precipitates the remainder of the alum, leaving only glucina and iron in solution. After distilling off the alcohol the iron and glucina are separated as in the first method.

METHOD OF PARSONS AND BARNES[17]

The powdered mineral (beryl) is mixed with its own weight of potassium hydroxide and fused in a carborundum crucible. The fused mass is broken up, just covered with water, and concentrated sulphuric acid is added in slight excess. The now gelatinous mass is heated and broken up until fumes of sulphuric acid are given off and the whole has the appearance of a fine white powder. The residue is next treated with hot water and on evaporation most of the aluminum crystallizes out as alum. Filter to separate the silica and the formed alum. To the filtrate which contains all the glucinum together with impurities add nitric acid and boil to oxidize the iron. Neutralize with ammonia and add enough sodium carbonate crystals to saturate the solution. Warm for 24 hr. with frequent stirring, when most of the glucinum will be left in solution almost perfectly free from aluminum and from nearly all the iron. Filter. The residue is re-dissolved and re-treated as above, and all the glucinum will be found in the bicarbonate solution. Treat with ammonium sulphide to remove any dissolved iron. Filter, dilute the filtrate to 5 times its original volume and blow steam through the solution to the boiling point, when the glucinum precipitates as a fine granular basic carbonate which is easily filtered and washed. The basic carbonate thus obtained is pure save for about 2 per cent of occluded sodium salt. To remove this salt the precipitate is dissolved in hydrochloric acid, boiled to remove carbon dioxide, and treated with ammonia. Allow to settle, filter and wash with ammonium acetate solution to prevent the formation of colloidal hydroxide. The residue consists of glucinum hydroxide, which on drying and calcining yields glucina.

METHOD OF JAMES AND PERLEY[18]

The mineral (gadolinite), crushed and pulverized, is treated in iron tanks with sulphuric acid, and heated until dense fumes of sulphuric acid are copiously evolved. The sulphated mineral is transferred into copper tanks, where it is stirred in a water solution. By adding the material slowly the temperature is not allowed to rise. The solution of sulphates is allowed to settle, the clear liquid is siphoned off and precipitated with a hot solution of oxalic acid. Allow to stand for 12 hr. Filter off the crystalline rare-earth oxalates and wash with boiling water. The glucinum and iron are in the filtrate, which is heated and treated with an oxidizing agent (say potassium bromate) in order to remove the excess of oxalic acid. Add ammonium hydrate followed by a concentrated solution of sodium hydroxide until the odor of ammonia is detected. Boil. The glucinum and iron are precipitated. Filter. The precipitate is treated with enough hydrochloric acid or sulphuric acid to dissolve about two-thirds of the whole, with constant stirring. This brings about the solution of all the glucinum and some iron. Filter. The residue is tested for glucinum, and if this is found, repeat the operation. The acid extract is heated to boiling and carefully precipitated with sodium hydroxide until a small amount of the filtered liquid gives a light colored precipitate with ammonium hydroxide, showing that nearly all the iron has been removed. Heat the filtrate to boiling, treat with an oxidizing agent to oxidize the iron, and precipitate with sodium hydroxide until a small amount of the liquid gives a white precipitate of hydroxide when treated with ammonia. Filter. The filtrate is treated with sodium-hydrogen sulphide to remove the last traces of iron. Filter. The glucinum is now precipitated as a basic carbonate by adding a concentrated solution of sodium carbonate to the boiling liquid. Filter. The precipitate is washed with boiling water, dried and calcined, yielding glucina.

METHOD OF COPAUX[19]

This method is based on the fact that sodium fluosilicate is decomposed at about 750 deg. C. into sodium fluoride, which fuses at about 980 deg. C., and silicon fluoride, a very active gas which at about 850 deg. C. decomposes the mineral beryl with the formation of sodium fluoglucinate and sodium fluo-aluminate, the fluoglucinate being very soluble in water and the fluo-aluminate (artificial cryolite) nearly insoluble. The mineral is powdered and mixed with twice its weight of sodium fluosilicate, and the mixture is heated to 850 deg. C. The cooled mass is easily pulverized and treated with boiling water. All the fluoglucinate and only a small quantity of the fluo-aluminate are dissolved. Filter. The filtrate is treated with ammonia to transform the fluorine salts into hydroxides. Filter. The precipitate is dissolved in sulphuric acid, and the solution concentrated by boiling until white fumes of sulphuric acid appear, when it is certain that all the hydrofluoric acid has been driven off.

---

[17] C. L. Parsons and S. K. Barnes. *Journal* Am. Chem. Soc., Vol. 28 (1906), pp. 1589-1595. See also C. L. Parsons, "The Chemistry and Literature of Beryllium," Chemical Publishing Co., Easton, Pa., 1909.

[18] C. James and G. A. Perley, *Journal* Am. Chem. Soc., Vol. 38 (1916), pp. 875-877.

[19] H. Copaux. *Comptes Rendus*, T. 168 (March 24, 1919), pp. 610-612.

It is now best to treat the sulphates by any one of the methods mentioned above for the purification of the glucinum salt in a solution of sulphates.

Chemical and Electrochemical Separation of Glucinum

METHOD OF WÖHLER

As mentioned before Wöhler was the first to separate glucinum metal by reducing glucinum chloride with potassium. He has studied the product obtained and has assigned to it properties which have not been corroborated by subsequent studies on glucinum. This was due to the fact that his product was very impure.

METHOD OF DEBRAY[20]

Debray in 1855 separated glucinum metal by reducing glucinum chloride with sodium in a current of hydrogen. The glucina is transformed into glucinum chloride by mixing it with charcoal and oil to the consistency of a paste and by heating this paste in a retort in a current of chlorine gas, when the glucinum chloride sublimes. The chloride and the sodium are placed in two separate parts of a retort cleaned of air by a current of hydrogen. Heat until the sodium fuses and the chloride vaporizes. The current of hydrogen carries the vapors to the fused sodium, when the chloride is decomposed with the formation of a dark mass consisting of sodium chloride and metallic glucinum. The mass is cooled and treated with water, which dissolves out the sodium chloride, leaving a residue of metallic glucinum of about 85 per cent purity.

METHOD OF NILSON AND PETERSSON[21]

Nilson and Petersson obtained the metal by heating to bright redness a mixture of glucinum chloride with a slight excess of sodium in a hermetically closed crucible of wrought iron. The separated glucinum was partly fused into globules and partly in the form of aggregations of little prismatic crystals, which in brightness and color resembled needles of polished steel. The average analysis of these two products gave 86.94 per cent glucinum, whereas the analysis of the globules gave 94.41 per cent metallic glucinum.

METHOD OF KRÜSS AND MORAHT[22]

Krüss and Moraht separated the glucinum by reducing potassium-glucinum fluoride with sodium. The glucina is transformed into the double fluoride by dissolving it in hydrofluoric acid, adding potassium fluoride to the concentrated solution and crystallizing out the salt repeatedly. The crystals were heated to bright redness for 30 min. with a calculated quantity of sodium in a steel crucible. The residue left, after washing with water, consisted of hexagonal crystals of glucinum and glucinum powder slightly contaminated with iron and glucinum oxide.

METHOD OF WARREN[23]

Warren has separated glucinum by electrolyzing glucinum bromide. The basic glucinum carbonate previously obtained (see page 356) is intimately mixed with an excess of lampblack and ignited out of contact with the atmosphere. The mass thus obtained is converted into glucinum bromide by the action of bromine vapors at a full red heat in a clay retort. The sublimed bromide is dissolved and reduced to metallic glucinum by an electric current of 8 amp. and 12 volts.[24]

METHOD OF BORCHERS[25]

Borchers separated glucinum metal by electrolyzing potassium-ammonium-glucinum chloride. Basic glucinum carbonate, obtained by any of the methods given above, is transformed into glucinum chloride by dissolving it in hydrochloric acid with the addition of potassium chloride and the solution evaporated to dryness, giving glucinum-potassium chloride. This is mixed with ammonium chloride, and placed in an iron crucible, which also forms the cathode. The anode consists of a carbon rod. Fuse the mixture, and the glucinum is reduced by a current of 1000 amp. per sq.m. of electrode at 5 volts. It is necessary to avoid too high a temperature, otherwise a glucinum-iron alloy is formed instead of the glucinum metal.

METHOD OF LEBEAU[26]

Lebeau obtained glucinum metal by electrolyzing sodium-glucinum fluoride. He prepared the double fluoride by dissolving in hydrofluoric acid exactly calculated proportions of glucinum hydrate and sodium carbonate and evaporating to dryness. The electrolysis is carried out very conveniently in a nickel crucible, which also serves as the negative pole, the positive pole consisting of a graphite rod which will not disintegrate under the influence of the current. First melt the salt by means of a bunsen burner, then pass the current and withdraw the heat. The mass remains in fusion. Avoid a heat exceeding a very dull red, otherwise alloys of glucinum-nickel will be formed. Use a current of 6 to 7 amp. and from 35 to 40 volts. The product obtained is a non-adherent, crystalline mass, which is isolated and treated with boiling water. After prolonged washing the disintegration is complete and the residue is a powder formed entirely of rather irregular crystals of glucinum of 99.81 per cent purity.

METHOD OF POLLOK[27]

Pollok separates glucinum by reducing glucinum chloride with sodium. He obtained the chloride by mixing glucinum oxide with four times its own weight of sugar and heating the mixture to a dull red. The mixture of carbon and glucinum thus obtained is heated in a porcelain tube maintained at a bright red heat, and a steady stream of perfectly dry chlorine gas is passed over the heated mass. The chloride condenses in white silky needles beyond the red-hot zone of the tube. This chloride is reduced by sodium in a nickel crucible. Sodium is placed at the bottom, then the chloride and then another layer of sodium. Cover well and heat until the reaction is complete. The whole mass is then plunged in absolute alcohol to dissolve the excess of sodium; boil with fresh portions of absolute alcohol, and finally wash with hot water. The glucinum thus obtained is a powder which after burnishing presents a white metallic luster.

---

[20] *Loc. cit.* 9.

[21] L. F. Nilson and O. Petersson, *Chemical News*, Vol. 42 (1880), pp. 297-299.

[22] Gerhard Krüss and Herman Moraht, *Ber.*, Vol. 23 (1890), pp. 730-732.

[23] *Loc. cit.* 14.

[24] This metal has been worked into jewelry articles and these are now in the possession of the Ameer of Afghanistan.

[25] W. Borchers, Z. Elektrochem. No. 3, 1895, pp. 40-41.

[26] P. Lebeau, *Comptes Rendus*, T. 126 (1898), pp. 744-746.

[27] *Loc. cit.* 16.

METHOD OF FICHTER AND JABLOCZYNSKI[28]

Fichter and Jabloczynski have separated the metal electrolytically by the method of Lebeau; but instead of using the salt composed of 1 molecule of glucinum fluoride and 2 molecules of sodium fluoride they reversed the proportions. They claim for this modification that the separation of the metal by dissolving the difficultly soluble sodium fluoride is made much easier. They obtained the double fluoride by mixing calculated quantites of glucinum carbonate or hydroxide with sodium carbonate and treating the mixture with hydrofluoric acid. The product is dried, fused and powdered. The powder is placed in a nickel crucible which also forms the cathode, the anode being a carbon rod. The current used is 7 to 10 amp. at 15 volts. The melt after electrolysis of 2½ hr. is removed from the crucible while still hot. After cooling and finely pulverizing, the substance is thrown, a little at a time, into a large volume of water with constant stirring. The salt dissolves almost immediately, the metallic residue being left on the bottom. The deleterious effect of the hydrofluoric acid which forms during the electrolysis is counteracted by the addition from time to time of a little ammonia and by frequent renewal of the water. The residue after washing with alcohol and drying gave on analysis 92.4 per cent glucinum metal. Microscopic examination revealed particles of glucinum oxide, which were separated mechanically by centrifuging the crude metal in ethylene bromide diluted with alcohol to a specific gravity of 1.95. The oxide settled at the bottom, leaving a 98 per cent pure metal suspended in the liquid. They also advise to avoid too high a heat, as they obtained during their work alloys containing 71.39 nickel and 27.61 glucinum, and one containing 72.07 nickel and 26.93 glucinum.

Brinton[29] followed the method of Fichter and Jabloczynski, but he found rather quantitative than qualitative differences in the results.

Properties of Glucinum

Glucinum is a white malleable metal, and can be easily forged and cold rolled into sheets. It takes a high polish and scratches glass, the hardness being between 6 and 7. Specific gravity 1.64[30]; atomic weight 9.1. Its melting point is not yet known definitely. Its specific heat is the highest of any useful metal. According to Humpidge[31] the specific heat varies with the temperature up to between 400 deg. and 500 deg. C., when it becomes nearly constant, about 0.62. (See Fig. 1.) Its latent heat of fusion is abnormally high, possibly 300 calories. Its latent heat of vaporization is probably higher than that of any known element, except carbon and boron. Its electrical conductivity is as high as that of silver, and thereby higher than that of copper. So far practically nothing is known about its tensile strength or rigidity, or about how it might be strengthened by small additions of other metals. Mendeleef[32] places glucinum in the same group with magnesium, calcium, strontium and barium, and gives the following correlative proportions:

Gl : Li : : B : Gl
Gl : Mg : : Li : Na : : B : Al
Gl : Al : : Li : Mg : : B : Si
Gl : B : : B : C

Glucinum does not exhibit allotropy. It is not altered in the air, nor does it burn even when heated to redness in a current of pure oxygen, but becomes covered with a thin coat of oxide which seems to protect it from further oxidation. It is not acted upon by cold or boiling water, nor by steam even at red heat. When heated by an electric arc in an atmosphere of hydrogen it volatilizes without fusion and condenses to a gray metallic mirror, like arsenic. It is not attacked by sulphur even when treated with sulphur vapors. Chlorine, fluorine and bromine attack it with incandescence and form the corresponding glucinum haloids. Iodine acts more difficultly. At the heat of an electric furnace it unites readily with silicon, forming a hard brittle substance susceptible of a high polish; it also unites directly with carbon and boron, and forms many alloys with a number of metals. It is attacked with evolution of heat by hydrochloric acid gas at a temperature produced by a small alcohol lamp and with evolution of hydrogen by dilute and concentrated hydrochloric acid. It is also attacked by concentrated sulphuric acid with evolution of sulphur dioxide, and by dilute sulphuric acid with evolution of hydrogen. It is not acted upon by dilute or concentrated nitric acid at ordinary temperature and only very slowly at a boiling heat.

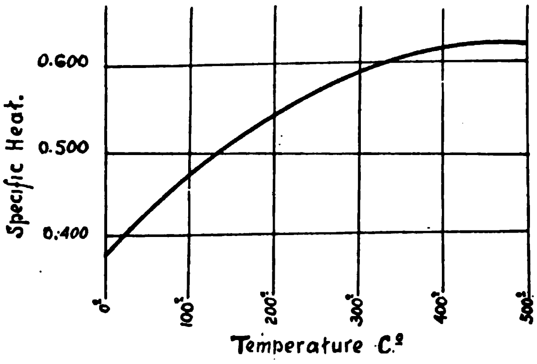


FIG. 1. CURVE SHOWING SPECIFIC HEAT OF GLUCINUM AT VARYING TEMPERATURES

It is not attacked by ammonia, but dissolves readily in a potash solution. Its salts are colorless when the acids are colorless, and a large majority of them are soluble in water. The solutions have a sweet taste and give an acid reaction. In dilute acid solutions glucinum is electro-negative to magnesium and electropositive to aluminum.

To quote again Dr. J. W. Richards:[33] "Beryllium (glucinum) is a metal which will well repay extended metallurgical research and minute physical and chemical study of its many unique properties."

---

[28] F. Fichter and K. Jabloczynski, *Ber.*, Vol. 46, pt. 2 (1913), pp. 1604-1611.

[29] P. H. Mallet-Prevost Brinton. Contributions to the Chemistry of Beryllium. A thesis (Univ. of Minnesota), Eschenbach Printing Co., Easton, Pa., 1916.

[30] J. W. Richards, a paper read at the Am. Inst. of Chem. Engrs., Cleveland meeting, June 14, 1916. See MET. & CHEM. ENG., July 1, 1916, pp. 26-27.

[31] T. S. Humpidge, *Proc.*, Royal Soc. of London, Vol. 39 (1886), p. 9.

[32] D. Mendeleef, *Chem. News*, Vol. 40 (1879), pp. 303-304.

[33] *Loc. cit.* 30.

Application of the Cottrell Process to the Recovery of Fume From Silver Refining Operations

Description of the Recently Installed Fume Precipitator at the United States Metals Refining Co. Works—Construction of Header Chambers, Electrode Tubes and Electrode System—Operation Control

BY W. G. SMITH[*] AND A. A. HEIMROD[†]

THE application of the Cottrell electrical precipitation processes found early recognition as a standard means of removing the suspended particles of fume from exit gases arising from copper and lead smelting operations, as well as in the recovery of of the fume from the further operation of refining the gold and silver by-products of these two major metals into commercial or marketable form.

It is the intent of this article, first, to touch briefly upon one of the earliest commercial Cottrell installations, placed in operation in one of the Eastern refineries, and, second, to describe in detail the latest developments in fume treatment by the Cottrell processes on virtually the same kind of fume. It is assumed that the readers of this article are familiar with the general principles of electrical precipitation, therefore these are not touched upon. Those, however, who wish to familiarize themselves on the terminology involved can do so by referring to the literature on the subject[1] in which will be found a very comprehensive discussion of its theory.

FIRST INSTALLATION AT THE RARITAN COPPER WORKS

The first commercial installation of this kind was the Cottrell plant installed at the Raritan Copper Works, Perth Amboy, N. J., where, in September, 1913, a box type precipitator was put into operation for the recovery of values in the fumes coming from furnace operations for the refining of copper slimes. This precipitator was of the horizontal gas flow type and was built in one section, having an active length of approximately 13 ft. and an active width of 8 ft. There were thirteen sets of discharge electrodes, making thirteen aisles or passageways in parallel through which the fume and gases passed and were subjected to the high voltage discharge from the discharge electrodes. These discharge electrodes consisted of 1-in. lead strips sharpened at the edges and spaced at equal intervals on the discharge electrode supporting frame. The gases, before they entered the precipitator, were passed through a scrubber and spraying system, where some of the fume in the gases was removed and the gas temperature lowered to approximately 150 deg. F. The spraying, in addition, performed the very vital function of humidifying the gases properly for later treatment in the precipitator and ultimately the scrubbers were eliminated. The operating voltage was 40,000 volts, with a total power consumption of 3 to 4 kw. The box type treater on this problem caused considerable trouble due to building up of the fume on the collecting and discharge electrodes, and this, together with the nature and the composition of the fume, necessitated continual attention by the operator in order to keep the precipitator in service at a high point of efficiency. This precipitator was, however, operated continually until the summer of 1916, when a pipe type installation was placed in service.

INSTALLATION AT THE U. S. METALS REFINING PLANT

Since the installing of the initial electrical precipitation installation at the Raritan Copper Works, the art of precipitation of silver refinery fume has been advanced to a marked degree. The latest development along this line is the installation which has very recently been completed and placed into successful commercial operation at the plant of the United States Metals Refining Co. at Chrome, N. J.

The electrical precipitation installation on the silver refinery gases at this plant is installed at the end of a considerable length of flue system in which is also located a large settling chamber, spraying and scrubbing apparatus. The precipitator proper consists of a steel frame supporting lead top and bottom headers, connected by means of lead precipitator pipes. Three units are provided, each of which is suitable for handling approximately 4000 cu.ft. of gas per min. at 115 to 150 deg. F. at a velocity of 7 ft. per sec. through the pipes, or in case of necessity 8000 cu.ft. per min. at a velocity of 14 ft. per sec. through the pipes with only a very slight decrease in efficiency.

Each precipitator unit is 8 ft. 8 in. x 8 ft. measured from the inside of the precipitator column supports and has an overall height from foundation to the peak of the open top header of 34 feet.

PRECIPITATOR LEAD LINED

All of the parts of the precipitator which come directly in contact with the gases are made entirely of the very best high grade U. S. Smelting, Refining & Mining Co. electrolytic lead, free from impurities of antimony. It has been found that the gases containing selenious and selenic acid destroy lead which contains as low as 0.1 per cent antimony, therefore no lead containing antimony was used in the construction. Any steel work that might be subjected to exposure to the gases was covered with lead in such a way that no fume could come in direct contact with the iron.

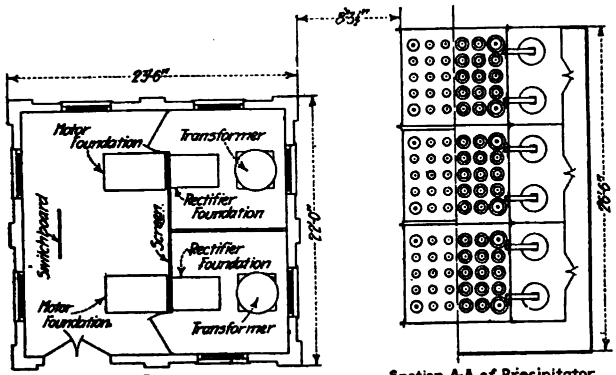
The fumes and gases from the furnaces used in the silver refinery operations are conducted into the bottom header through an inlet at each side of each unit close to the top of the bottom header chamber. Each of these inlets is provided with a liquid seal gas-tight jug damper in order to permit the shutting off of any unit and clear it entirely of gas without interfering with the operation of the remaining units, thereby giving to the whole installation flexibility and assuring continuous operation. These jug dampers are located on and supported by the top of the 2 ft. x 3 ft. rectangular bustle pipe extending along each side of the precipitator units. This bustle pipe is in turn supported by hanger rods from the main structure. (See Fig. 1.)

---

[*] Metallurgist, U. S. Metals Refining Co., Chrome, N. J.

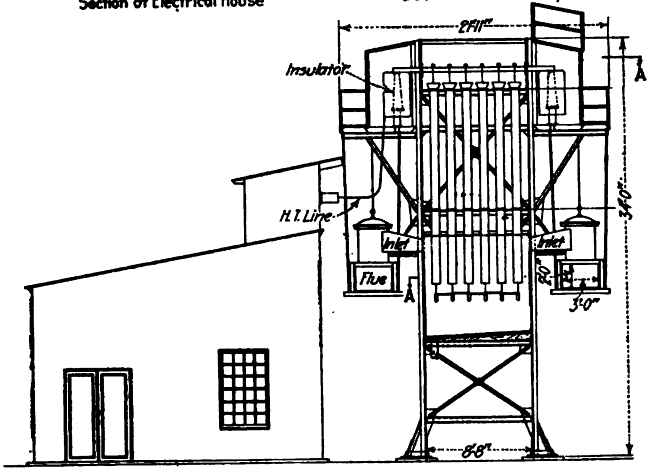
[†] Division engineer, Engineering Department, Research Corporation, N. Y.

[1] "Problem in Smoke, Fume and Dust Abatement," F. G. Cottrell; *Smithsonian Reports*, 1913. "Recent Progress in Electrical Smoke Precipitation," F. G. Cottrell; presented before the Second Pan-American Scientific Congress, Washington, D. C., Dec. 27, 1915, to Jan. 8, 1916. "Cottrell Processes of Electrical Precipitation," Walter A. Schmidt; *Trans. Am. Inst. Chem. Eng.*, vol. 8, 1915. "The Cottrell Precipitation Process and Its Application to Foundry Dust Problems," H. D. Egbert; American Foundrymen's Association, Milwaukee, Oct. 7-11, 1918. "Treatment of Silver Furnace Fume by the Cottrell Process," C. H. Aldrich; *Trans. Am. Electrochem. Soc.*, vol. 28, September, 1915.



Section of Electrical House

Section A-A of Precipitator



Elevation of Electrical House

Cross-Section of Precipitator

FIG. 1. CROSS-SECTIONS AND PLAN OF COTTRELL INSTALLATION, U. S. METALS REFINING CO.

The bottom header chamber is made of 8-lb. lead, the end walls being supported by lead clips fastened to the structural steel frame. In the bottom of the header box a 6-in. diameter lead drain pipe is provided in order to facilitate the flushing out of the collected precipitated material into settling tanks located alongside the precipitator. Ready accessibility to the bottom header is provided by means of doors which can be easily opened to inspect the electrode systems.

Collecting Electrode Pipes

Each precipitator unit has 30 collecting electrode pipes 16 ft. long. Twenty-six of these pipes have an internal diameter of 8-in. and the four corner pipes have an internal diameter of 11 in. The increased diameter of these corner pipes permits installing of a stiff electrode to steady the discharge electrode system and prevent it from swinging or swaying due to irregularities of gas flow or in electrical conditions. This avoids the use of insulators in the bottom header and thereby eliminates possibilities of insulator leakage trouble at this point. (See Fig. 1.)

The precipitator pipes extend into the bottom header 4 ft. The gas inlets are so arranged that the gas flows in near the top of the bottom header box, circulates around the pipes, flows down to the bottom, then up through the pipes and discharges into the top header box. This arrangement tends to break up any irregularities in the flow of the incoming gases, equalizes the gas pressure in the bottom header, tends to heat all of the pipes to a uniform temperature and thus insures proper distribution of the gas in the various pipes. The gases passing through the electrical field are cleaned and are discharged at the top of the precipitator into the top header and to atmosphere. The solid and liquid particles carried by the gas are collected on the inside surfaces of the collecting electrode pipes, from which the precipitate is periodically washed into the bottom header by means of a washing system installed in the top header. This cleaning operation is performed only on idle units, the gas temporarily being diverted to other units and the electric power line switch opened. This can readily be done, as high voltage selector switches have been installed in the electrical house whereby a precipitator unit can be put in or taken out of service without disturbing the operation of the electrical equipment or gas flow to the remaining units.

The top header of each precipitator unit is lead lined throughout and open to atmosphere at the top. The end walls of these headers have been provided with two openings to allow the high tension framework to pass through to the steel insulator compartments, where it is supported on 3-ft.-high corrugated pillar type insulators. These are properly hooded with steel hoods in order to protect the insulators from moist gas and bad weather conditions.

The installing of the collecting electrode pipes was accomplished by passing a mandrel through the pipes so as to remove any irregularities such as projections or dents. They were then passed through the lead-covered steel top header supporting plate, which was drilled to allow the pipes to pass through freely to the second steel lead-covered supporting plate 9 ft. 9 in. below the top header. After the pipes were in place they were burned to the sheet lead covering on the supporting plates and to the top plate of the lower header, thereby making the pipes hang plumb and assuring a tight joint around pipes where they enter the bottom header.

The Electrode System

The discharge electrode system of each unit consists of, first, four corrugated pillar type insulators[2], two on each side of the precipitator unit, insulating the high tension frame from ground, these insulators, as stated before, being protected against bad atmospheric conditions by means of sheet iron hoods. Second, the electrodes are made up of a star section lead-covered iron wire, carefully centered in the pipes and supported from 2-in. pipe bus bars. The corner pipes have stiff electrodes made of 1½-in. lead-covered extra heavy wrought iron pipe. Around that portion of the electrode that is in the precipitator pipe is a spiral of star section lead-covered iron wire[3] the same as used in the other pipes. Third, the electrode system is tied together at the bottom by a sway frame to the stiff corner electrodes, and on the end of each electrode in order to hold it straight in the center of the pipe is a 20-lb. lead weight.

---

[2] Research Catalog No. 5-J-3.

[3] Research Catalog No. 3-E-1.

ELECTRICAL EQUIPMENT

The electrical equipment for the transformation of the available power supply at 250 volts direct current to the required potential of 65,000 volts is placed in a building close to the base of the precipitator.

The supply lines run through a main line switch and fuses mounted in a steel cabinet on the wall and from this point to the switchboard. This arrangement makes it possible to disconnect entirely the main switchboard buses and all auxiliary wiring from the power supply lines.

The switchboard consists of two slate panels, each having a main and a lower section, and each controlling independently one of the duplicate sets of electrical apparatus. The lower panel sections are reserved for the motor starter face plate, manual operating handle, overload and under voltage trip coils. The main sections of each panel have mounted upon them all the control equipment except the motor starters and high tension switching devices. On each main section is a single pole circuit breaker in the motor circuit (protecting that side of the circuit not protected by the overload coil on the motor starter); a main line motor switch; a generator field switch and a field discharge resistance; a generator field rheostat operating handle (with rheostat on the back of the panel); a double pole, overload trip, under-voltage release, circuit breaker in the line from the generator to the transformer; a rheostat switch; a double pole double throw reversing switch and a transformer tap switch in this same line; and a voltmeter and an ammeter in the transformer circuit. By means of a potential plug the voltage may be measured either at the generator terminals or the transformer terminals, the difference being the voltage drop across the line rheostat (plus a small line drop).

GENERATOR EQUIPMENT

The two motor generator sets consist of a 40-hp., 220-volt, 150-amp. motor and a 25-k.v.a., 220-volt, 113-amp. single-phase 60-cycle generator, both manufactured by the Westinghouse Electric & Manufacturing Co., and supplied to generate the alternating current. The mechanical rectifiers, directly connected to and therefore operated in synchronism with the motor generator set, were manufactured and supplied by the Research Corporation. Near the rectifiers are the high voltage transformers rated as follows: 25 k.v.a., 200 volts low tension, 75,000 / 70,000 / 65,000 / 60,000 / 55,000 volts high tension; 60 cycles, complete with oil gage and choke coils. The arrangement of the apparatus is such that the high-tension equipment of each set is completely screened off from the other set and from the low-tension apparatus.

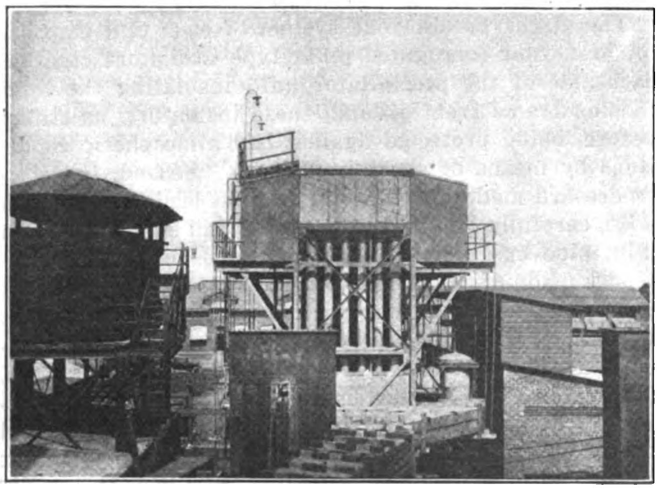


FIG. 2. INSTALLATION IN OPERATION WITH 8000 CU.FT. OF GAS, CURRENT ON

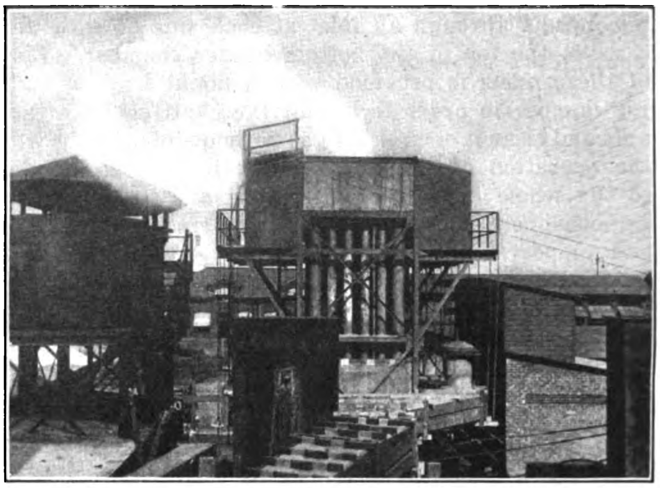


FIG. 3. INSTALLATION IN OPERATION WITH 8000 CU.FT. OF GAS, CURRENT OFF

The "path" of the electric power is from the generator at 220 volts, single phase, 60 cycles, through the switchboard control equipment and line rheostat to the transformer at the same frequency but at reduced voltage (line rheostat drop). The transformer "steps up" the voltage to about 65,000 volts and furnishes power at this voltage directly to the mechanical rectifier without going through any switching devices. Choke coils in the transformer circuit and resistances in the line afford protection against surges. The rectifier reverses the polarity of one-half of each complete cycle and supplies unidirectional current at about 65,000 volts to its main high-tension bus. One terminal of the rectifier is permanently grounded. Each rectifier is connected directly without switching devices to its individual high-tension bus. The three lines from the precipitator units are brought in through the wall of the building near the roof to three separate switching buses, which are so arranged that by means of a grounded mechanical remote control handle near the motor generator sets any or all of the three precipitator units may be connected to either of the main power buses. These switches can be operated with the buses alive, and the change over from one unit to another can be made in a very short time. It is good practice to reduce the voltage about 25 per cent before undertaking any high-tension switching. The high-tension switches are provided with padlocks so that a mechanic before going to work on a precipitator unit can lock the switch in an open position, take the key with him and be certain that voltage cannot be applied to the unit upon which he is working, the operator meanwhile being free to manipulate the two other precipitator units without interference.

THE PRECIPITATOR AND ITS OPERATION

A fair idea of the precipitator may be obtained by examining Figs. 2 and 3, which show the end view of one unit; top header, insulator compartment, pipes, part of the bottom header, jug damper and main flue system. Part of the electrical equipment building with monitor, to hold the inlet bushings, can be readily located alongside the flue system.

Fig. 2 shows the precipitator operating at full capacity under normal operating voltage and Fig. 3 with the high-tension current shut off. The fume being very light in color, it is difficult to obtain a clear idea from the photograph of the contrast between "current on" and "current off" conditions, but careful note of the lamps on the top platform in each illustration will serve to emphasize this difference.

The precipitator operates as close to 100 per cent clearance as any one can wish for, and this condition is always maintained on account of the high values in the fume recovered. As soon as this precipitator becomes overloaded with the precipitated fume in the precipitator pipes the operator can readily detect this condition by his instruments on the switchboard and by the general operation and appearance of the spark at the rectifier. The high-tension selector switches in the electrical equipment house are then operated, to cut in the spare unit; the jug dampers on the inlets to the units are opened or closed as the case may be to put the unit into service or to take it out. The precipitate is then washed from the pipes by means of the flushing system. This operation varies, due largely to the selenium content of the fume; the higher the percentage of selenium in the precipitated fume the more often it is necessary to take a unit out of operation to clean the collecting and discharge electrodes.

The recoveries, judging from the short time the precipitator has been in operation, will be even greater than those indicated by the preliminary single pipe tests based on which appropriations for the construction of the commercial installation were readily made.

Exportation of Refined Sugar From U. S.

The suspension of the exportation of refined sugar from the United States by order of the United States Sugar Equalization Board, in order to correct local deficiencies and prevent the upward movement of local prices, lends interest to a statement compiled by the National City Bank of New York showing the exportation of refined sugar from the United States during the last fifty years. It shows that the quantity of refined sugar exported in the 5 years since the beginning of the war is more than double that of the half century preceding the war. The quantity sent out of the country in the 5 years ended with June, 1919, is in round terms, 5,000,000,000 lb., against 2,000,000,000 lb. in the half century preceding the war, and the value in the 5-yr. war period was $290,000,000, against $120,000,000 in the half century prior to the war.

The sudden demands on the United States for refined sugar which came with the beginning of the war, says the bank's statement, is due to the fact that most of the European countries which had formerly relied for their sugar upon the beet fields of Germany, Austria-Hungary and Russia found their usual supplies cut off by the war and were compelled to look to the cane sugar area of the world for supplies. The cane sugar area is chiefly Cuba, Porto Rico, Hawaii, the Philippine Islands, Java and India. Cuba and our own islands send their raw sugar to the United States to be refined; India consumes all of its sugar locally; and Java exports a large proportion of her product in the raw state to her neighbors in the Orient, especially India, Australia and Japan. The Latin-American countries, which produce about 1,000,000 tons annually, have little for exportation. This left Cuba and the islands belonging to the United States as the chief available source for cane sugar, and as all of these islands have been sending their raw products to the United States for refining, quite naturally the European countries requiring sugar turned to this country for supplies of the refined article.

As a consequence of this condition the quantity of refined sugar exported from the United States in our fiscal year 1915, the first year of the war, was 550,000,000 lb., in 1916 1,630,000,000, in 1917 1,250,000,000, in 1918 575,000,000 and in 1919 about 1,000,000,000 lb.

While export prices prior to the war were much higher than those in the period immediately preceding the war, they were materially less than those in the early part of the 50-yr. period prior to the war. The average export price of the refined sugar sent out of the United States during the war ranged from 4.7c per lb. in 1915 to about 7.1c in 1919, while the average export price in 1871 was 13.2c per lb., in 1875 10.8c, in 1880 9.0c, 1890 7.0c, 1900 4.5c, 1905 3.5c, and in the fiscal year 1914, all of which preceded the war, 3.6c.

While most of the exportation from the United States has gone to Europe, the other parts of the world are gradually turning to the United States as a new source of supply, and the exports of refined sugar in the fiscal year 1918 were: to Argentina 93,000,000 lb., Uruguay 21,000,000, Mexico 18,000,000, Canada 12,000,000, Africa 4,500,000, and to Asia (chiefly Japan and India) nearly 1,000,000 lb.

This habit of the cane sugar producers of America of sending their product to the United States to be refined grew out of the fact that the United States was the chief consumer of their product, while Europe, the other great sugar-consuming section of the world, was supplied from the beet fields, especially those of Germany, Russia, and Austria-Hungary. The United States consumed at the beginning of the present century one-fourth of the sugar of the world, but with the great enlargement of world production which followed the year 1900 the share of the world's crop consumed by us fell to about one-fifth, although the quantity consumed by us steadily increased. World production in 1900 was 19,000,000 lb., in 1910 33,000,000,000 and in 1914 42,000,000,000, and as a consequence of this tremendous increase in production, the percentage of the world's crop consumed by us fell from 25.7 per cent in 1910 to 20.9 per cent in 1914, although our consumption grew from 4,477,000,000 lb. in 1900 to 8,793,000,000 in 1914.—*Fortnightly Information Review*, Aug. 1, 1919.

Foreign Trade of France for Six Months

Imports into France for the first 6 months of 1919 were valued as follows: Food products, 3,488,837,000 francs; industrial material, 5,000,621,000 francs; manufactured articles, 3,638,745,000 francs; total, 12,128,203,000 francs.

Exports were: Food products, 249,272,000 francs; industrial materials, 382,190,000 francs; manufactured articles, 1,464,875,000 francs; postal packages, 162,147,000 francs; total, 2,258,484,000 francs.

Imports from the United States were valued at 3,774,858,000 francs; from England, 3,243,306,000 francs; and from Argentina, the next important country, 567,389,000 francs.

Exports to the United States totaled 160,492,000 francs; to England, 533,156,000 francs; and to Belgium, the next important country, 262,152,000 francs.

Notes on the Metallurgy of Wulfenite*

Source and Importance of Wulfenite—Description of Its Metallurgical Treatment, Acid Leach, Alkaline Leach, and Fusion Methods—Comparison of These Methods—Costs of Treatment—Tabulated Results

By J. P. BONARDI
Assistant Chemist, U. S. Bureau of Mines

VERY little information concerning the hydrometallurgical treatment of wulfenite ores has appeared in the technical journals. Those who have developed processes for the treatment of such ores are either working the methods behind closed doors or have patented their ideas and, as a consequence, little is generally known about the subject.

The molybdenum market at the present time is being supplied principally from the ore molybdenite, MoS_2. This has been chiefly due to the fact that there are larger deposits of this mineral than wulfenite in the United States. The advent of flotation and its adaptability to the concentration of molybdenite resulted in the United States producing, during the war, more molybdenum than any other country in the world; and it would be safe to say that nearly 90 per cent of this came from molybdenite ores. The principal working deposits of this ore are located in Colorado, at Climax and at Empire. Other deposits being worked at the present time are at Questa, New Mexico, and near Nogales, Arizona. Colorado, Arizona, New Mexico, California, Montana and Washington constitute the principal States where either molybdenite or wulfenite, or both, occur. These, as well as the minor deposits of molybdenum ores in the United States, are described by F. W. Horton.[1]

SOURCE AND IMPORTANCE OF WULFENITE

Until recently wulfenite ores constituted the principal source of molybdenum in this country. Horton[2] states that:

"Wulfenite ores from Arizona have supplied the larger part of the molybdenum produced in this country to 1915, and on account of the ease with which they are concentrated they should prove a strong competitor of molybdenite for markets that do not require concentrates with a high molybdenum content."

Besides the deposits occurring in Arizona, wulfenite has been reported in several scattered localities throughout the Western States of Nevada, New Mexico, Utah, California and Montana. Several of these deposits of wulfenite might be worked at a profit and would have a better chance to compete with molybdenite if sufficient information could be obtained concerning a profitable metallurgical treatment for the concentrates.

The successful concentration of wulfenite ores presents few difficulties, as the ordinary wet processes of concentration by jigs, tables and vanners, such as are used in the concentrating mills for treating lead, copper, zinc and pyrite ores, may be applied with success on wulfenite ores, which are also amenable to pneumatic separators of various types. Vanadinite and several of the lead minerals—cerussite, anglesite, galena, pyromorphite and mimetite—which oftentimes occur with wulfenite are also recovered in the wulfenite concentrates, being of practically the same specific gravity. Usually a concentrate of 15 to 20 per cent MoO_3 is the best obtainable when the above-mentioned lead minerals occur to any extent in the ore. A pure wulfenite mineral contains 39.23 per cent MoO_3 and 60.77 per cent PbO. Wulfenite buyers sometimes specify that the ore should contain a minimum of 20 per cent MoO_3, or 13.33 per cent Mo. Though the presence of other lead minerals would lower the grade of concentrates, any smelting process employed would recover the lead, which would also carry along the precious metals, gold and silver, which sometimes are found associated with the wulfenite crystals or in the lead gangue minerals. Horton[3] cites a case where gold was found as native metal in the wulfenite crystals themselves. The Mammoth mine, about 3 miles from Mammoth, at Shultz, Pinal County, Arizona, was worked originally for its free gold content. Part of the tailings from these workings later supplied 750 tons of wulfenite concentrates out of 795 tons of combined wulfenite and molybdenite concentrates that constituted the total production of this country in 1903.[4]

PURPOSE OF INVESTIGATION

In view of the little that has been published concerning the metallurgical treatment of wulfenite ores and the difficulties connected with some of the processes used, it was deemed advisable to make a preliminary study into the metallurgical possibilities of wulfenite. Although the now known commercial deposits of wulfenite may not be able to supply the molybdenum demand even in normal times, this mineral may still prove to be a strong competitor of molybdenite in the future. Wulfenite offers some advantage over molybdenite in that any successful process for recovering molybdenum would necessarily recover the lead and any precious metals as by-products, and thus reduce the cost of treatment.

The material used consisted of wulfenite concentrates kindly furnished by the Rowley Copper Mines Co., Gila Bend, Arizona. Analysis of the concentrate gave the following results:

	Per Cent		Per Cent
MoO_3	23.77	Mo	15.85
PbO	47.93	Pb	44.53
Fe_2O_3	1.16		
Al_2O_3	1.34		
SiO_2	4.90		
V_2O_5	.74		
P_2O_5	.20	P	.08
As_2O_5	1.02	As	.66
$BaSO_4$	18.56		
Total determined	99.62		

---

*Published by permission of the Director of the Bureau of Mines.

[1] Horton, F. W., "Molybdenum, Its Ores and Their Concentration." Bulletin 111, Bureau of Mines, 1916.

[2] *Loc. cit.*, p. 45.

[3] *Loc. cit.*, p. 115.

[4] Pratt, J. H., "The Steel-Hardening Metals: Mineral Resources, U. S., for 1903," U. S. Geol. Survey, 1904, p. 308.

An assay for gold and silver gave respectively 0.007 and 0.293 oz. per ton of material, quantities altogether too low to justify commercial recovery. The above content of MoO_3 indicates a product containing 60.59 per cent of lead molybdate. Although the sample could have been graded up by elimination of the barium sulphate and siliceous gangue matter, this was not deemed advisable, since the molybdenum content was representative of the usual run of wulfenite concentrates. The presence of vanadium, arsenic and phosphorus and the excess of lead oxide indicated the presence of vanadinite, mimetite, pyromorphite and other lead minerals. Aside from the contained molybdenum, the material would be considered a valuable ore to smelt for its lead content alone.

METALLURGICAL TREATMENT

Any metallurgical treatment for wulfenite ores should include the recovery of the lead and precious metals besides the molybdenum. The principal methods may be classed under three general heads:

(1) An acid leach.

(2) An alkaline leach.

(3) Fusing the ore with some material that will give the lead in metallic form carrying the gold and silver, and the molybdenum as a soluble compound in the slag which can be extracted by solution methods or may be used directly in the electric furnace for the preparation of ferromolybdenum.

(1) Acid Leach Method. Treating wulfenite material with any acid or combination of acids did not offer any special advantage. Wulfenite is only soluble in acids when used in considerable excess and concentration. The cost of alkali to neutralize such a solution, in order to obtain proper conditions to precipitate the molybdenum from solution, is prohibitive. Further, lead is found in solution, or in the residue, depending upon what acid is used, and requires further treatment. Experiments conducted in this laboratory upon vanadinite concentrates which respond with acids similarly to wulfenite indicated the necessity of large excess of acids to effect complete solution and therefore considerable quantities of alkali for neutralization prior to precipitation. If an ore contains any gold or silver values, the recovery of such values with such a treatment requires further expense. In addition, the elimination of arsenic, phosphorus or other elements from solution makes this method of treatment complicated and expensive. If molybdenum is to compete with vanadium, an expensive method of ore treatment cannot be used, even though the metal vanadium has a high price at present. In view of these facts, detailed experiments were not conducted with acids, as the smelting processes, described later, offered better possibilities for recovering the lead as bullion together with any gold or silver values.

(2) Alkali Leach Method. Strong solutions of caustic or alkali carbonates will render only a very small percentage of the wulfenite soluble, so these methods of treatment were discarded. The solubility of wulfenite in hot sodium sulphide solution was first noticed by the writer during the course of sulphidizing wulfenite material previous to flotation experiments. The solubility of wulfenite in sodium sulphide is fairly complete in boiling solution, and from this solution, after the elimination of impurities, such as phosphorus and arsenic, the molybdenum can be recovered as calcium molybdate. The exact conditions necessary for precipitating molybdenum as calcium molybdate from alkali solutions will be described later in detail under fusion methods.

The sodium sulphide treatment offers an excellent method for treating wulfenite, as the lead, together with the precious metals, will be found in the residue as sulphides in a concentrated form, which can easily be shipped to the smelters for further treatment. The molybdenum goes into solution as sodium molybdate.

A method, somewhat similar, for treating vanadinite is described by G. Fester in German patent No. 294,932.[5] A description of this method is as follows:

"A V-Pb ore is finely ground and boiled, with stirring, with a solution of Na_2S, whereby the following reaction takes place: $Pb_3(VO_4)_2 + 3Na_2S = 3PbS + 2Na_3VO_4$. The resulting solution, still containing an excess of Na_2S, is saturated with fresh ore according to the counter-flow process, whereby all sulphur is taken up by the lead ore with the production of a sodium vanadate solution entirely free of sulphide, from which ammonium vanadate can be separated by means of ammonium chloride. If vanadic acid or iron vanadate is to be obtained, Cl is conducted into the hot sodium vanadate solution, until it is only weakly alkaline. By this treatment, at first small amounts of dissolved SiO_2 and Al_2O_3 are separated; secondly, the thiosulphate formed from the sulphide by oxidation is further oxidized to sulphate, and thirdly, arsenite is converted into arsenate and can be precipitated in the known manner as the ammonium magnesium double salt, together with any H_3PO_4 which may be present. From the purified solution V_2O_5 is obtained by acidifying, or iron vanadate is obtained by the addition of $FeSO_4$."

It is known that the method of treating wulfenite concentrates with sodium sulphide is now being used by at least one company in the United States. This company is now producing high-grade calcium molybdate of about 60 per cent MoO_3 content, practically free from sulphur, phosphorus and arsenic. The high-grade calcium molybdate thus produced can be used for the manufacture of ammonium molybdate, ferromolybdenum, or added directly to molten steel in the manufacture of special alloy steels.[6] The molybdenum in the calcium molybdate is easily reduced to the metal by the carbon or silicon in the steel at the temperature of the molten bath. This method of utilizing calcium molybdate has the further advantage of introducing only small impurities into the steel, but allowance must be made for the carbon used in reducing the calcium molybdate.

(3) Fusion Method. Since it is desirable to collect the lead as bullion, which requires a reducing flux in the treatment of the ore, it would be useless to try any melt which would not give reducing conditions, even though the molybdenum could be leached from the fused mass. A calcium chloride flux would react to form calcium molybdate, which would be insoluble in water. Attempts to fuse wulfenite ore with the common fluxes, such as niter cake, sodium bisulphate, sodium nitrate, sodium sulphate, calcium chloride, sodium chloride, or a combination of these chemicals with carbon, were not made therefore, except with salt.

---

[5] Fester, G., "Extracting Vanadium Ores by Treatment With Alkali Sulphide," *Chem. Abstr.*, vol. 12, No. 8 (1918), p. 953.

[6] Kissock, Alan, "Process of Making Alloy Steel," U. S. Patent 1,300,279, April 15, 1919.

In the fusion conducted with salt it was found that molybdenum would volatilize as the chloride, the amount depending upon the duration of treatment and the temperature. Attempts to use excess of salt and carbon, besides volatilizing some molybdenum, gave no lead button. When four parts of molybdenite ore were treated with one part of sodium chloride in a clay scorifier at 1000 deg. C. as much as 98 per cent of the molybdenum was volatilized.

FUSION EXPERIMENTS WITH SODA ASH AND CARBON

One commercial fusion method involves the use of soda ash and carbon. The lead is recovered as bullion along with any gold or silver, while the molybdenum remains in the slag as sodium molybdate. The sodium molybdate slag, if sufficiently high in molybdenum content, is used in the electric furnace in the manufacture of ferromolybdenum. The ore, soda ash and carbon are charged into a lead blast-furnace of the ordinary type, or water-jacketed, and the charge smelted to recover the lead as bullion. The proportion of fluxing material varies with the class of ore treated, but in all cases a considerable excess is necessary to insure a high recovery of the molybdenum. A similar method was used at one time for smelting vanadinite ore at Cutter, New Mexico. The method is described by Grider.[7]

In the above method it is desirable that the slag shall carry as much molybdenum as possible, with a minimum amount of alkali, on account of the corrosive action of the alkali on the linings of the furnaces used for making ferro. On account of this difficulty, the method has been more or less discontinued.

In view of these facts, it was deemed advisable, first, to determine the minimum amount of fluxing material necessary to recover completely the lead as bullion and at the same time extract the molybdenum as sodium molybdate; and, second, to recover the molybdenum from the slag as a product which when used in an electric furnace would eliminate the trouble heretofore experienced with the furnace linings.

The possibility of precipitating a molybdate as calcium molybdate having less basic properties than sodium molybdate was suggested to the writer in the fall of 1917 by Dr. R. B. Moore, superintendent of the Colorado Station. Previous to this time, in 1915-1916, attempts had been made in the laboratory of the Colorado Station to precipitate a molybdate from an alkali leach using calcium chloride, barium chloride and ferrous sulphate, but in no case was the precipitation complete; and no further attempts were made until the early spring of 1918. During the past year, working at interrupted intervals, a series of fusion experiments have been conducted, and the exact conditions for precipitating molybdenum completely as calcium molybdate have been found.

The following data represent the results of the experiments which, though performed on a small scale, are applicable to commercial conditions. Since the exact conditions for precipitating calcium molybdate have been determined, they can be applied to any sodium molybdate slag produced either by the fusion process or by the alkali sulphide leach method. Many of the standard textbooks on chemistry have mentioned the compound calcium molybdate, but the details for complete precipitation from solution are lacking.

Several preliminary fusions were conducted using soda ash and carbon. The sample of wulfenite concentrate which has been described was crushed to pass 100 mesh, and all fusion experiments were conducted upon this material. By using a minimum charge of soda ash and carbon (0.75 soda ash, 1 ore; 0.05 carbon), the lead could be completely reduced to the metal, but in order that this should collect in a button the maintenance of a high temperature was required. This was probably too high for a lead blast-furnace, without seriously affecting the furnace lining. It was found that the molybdenum from such a fusion could be completely leached from the slag. Sodium carbonate alone has a melting-point of 849 deg. C. and, when mixed with ore in about equal proportions, a considerably higher temperature is required before the mass becomes liquid. Although soda ash can be used for smelting wulfenite to form soluble sodium molybdate, the use of salt and sodium hydroxide in combination with soda ash presents some advantages, since such a mixture requires a lower temperature to effect a fusion, and consequently gives less trouble with furnace linings. Salt, besides the above advantages, would, if successful in replacing soda ash, effect a saving in cost of chemicals. On the other hand, although caustic soda costs a little more than soda ash, the advantages gained in its lower melting-point and its efficiency in decomposing wulfenite would probably repay the additional charge over soda ash used alone.

FUSION EXPERIMENTS WITH SODA ASH, SALT AND CARBON

Table I gives in a brief form the results of the fusion experiments using soda ash, salt and carbon.

In the following runs and subsequent experiments, fusions were made in iron-spun crucibles in a small electric furnace and carried to the point where the mass became liquid. While hot, the fused mass was poured into a conical iron mold so that the lead button could be collected and weighed separately. After cooling, the fused mass was broken up, dissolved and filtered, and the filtrate made up to a volume of one liter. An aliquot portion of 10 cc. was taken for analysis and for the alkalinity tests as described later. The molybdenum was determined after making this alkaline solution acid with sulphuric acid, then passing the solution through a Jones reductor and titrating with a one-twentieth normal permanganate,

TABLE I

No. of Run	Weight of Ore, Grams	Weight of Na_2CO_3, G.	Weight of NaCl, G.	Weight of Charcoal, G.	Ratio Ore to Na_2CO_3	Ratio Ore to Flux	Extraction Mo as Sol. Sodium Molybdate	Recovery of Pb as Metal in a Button	Remarks
1	10	10	10	1	1:1	1:2.1	85.09	80.90	Metallic lead globules disseminated throughout mass.
2	10	5	20	1	:0.5	1:2.6	83.10	No button	Metallic lead globules remained in slag.
3	10	20	10	1	1:2	1:3.1	89.30	87.60	Lead globules in slag.
4	40	30	40	2	1:0.75	1:1.8	92.7	70.80	Lead globules in slag.
5	40	40	40	2	1:1	1:2.1	97.4	80.30	Lead globules in slag.
6	40	80	40	2	1:2	1:3.05	98.2	90.40	Lead globules in slag.

---

[7] Grider, R. L., "Concentration and Smelting of Vanadium Ore." *Min. and Sci. Press*, vol. 113, No. 11 (1916), p. 389.

FUSION EXPERIMENTS WITH SODA ASH, CAUSTIC SODA AND CARBON

In Table II the results are given for the fusion experiments using soda ash, caustic soda and carbon.

TABLE II

No. of Run	Wt. of Ore, Grams	Wt. of Na_2CO_3, G.	Wt. of NaOH, G.	Wt. of Charcoal, G.	Ratio Ore to Flux	Extraction Mo as Sol. Sodium Molybdate	Recovery of Pb as Metal in Button	Remarks
7	40	8	5	2	1:0.33	53.20	89.40	Lead reduced to metal stuck to side of crucible. Fluid.
8	40	8	10	2	1:0.50	59.60	96.90	Fluid.
9	40	8	20	2	1:0.75	96.70	98.5	This fusion and subsequent runs required lower temperature to fuse than runs 7 and 8.
10	40	8	30	2	1:1	97.80	99.0	Fluid.
11	40	8	40	2	1:1.25	99.10	96.6	Fluid.
12	40	8	40	2	1:1.25	91.05	98.9	Fluid.
13	20	20	10	1	1:1.55	93.90	97.8	Fluid.

A review of the results of the experiments as given in Table I shows that the use of sodium chloride with soda ash, although it lowered the temperature of fusion somewhat, did not indicate that it could be substituted for soda ash, as the per cent recovery of lead and molybdenum fell off in attempts to use a flux containing less than 75 per cent soda ash to ore. The lead globules do not run together so well into a button when the soda ash is decreased and the salt increased in the fluxing charge. In a run using straight salt and carbon there was no reduction of the lead to metallic form. Further, at the temperature which the fusion required, there was a loss of molybdenum, as the chloride, from the baked cake on the side of the crucible.

The use of soda ash and caustic in combination, as shown in Table II, Run 9, where the ratio of ore to combined fluxing material was 1:0.75, gave over 95 per cent recovery of lead and molybdenum. This run was the best from the standpoint of molybdenum extracted and lead recovered, with the minimum amount of fluxing material. Runs 7 and 8 gave good recoveries of lead, indicating that the lead minerals had been decomposed, but not enough excess alkali was left over from the reaction to combine with the molybdic oxide to make the most soluble salt of sodium molybdate. Molybdic oxide combines with the requisite quantity of sodium carbonate or caustic soda to form at least six different molybdates from the normal sodium molybdate ($Na_2Mo_4 . 2H_2O$), the most soluble variety, to decamolybdate ($Na_2Mo_{10}O_{31} . 12H_2O$), which is only slightly soluble. The least soluble is the sodium octomolybdate ($Na_2Mo_8O_{25} . 4H_2O$); this compound under the proper conditions can be crystallized out of solution. As a salt of this character had no special advantage for recovering molybdenum from solution outside of its purity, no attempts were made to make use of this insoluble property of octomolybdate.

The use of a proportion of flux—less than 75 per cent of the weight of ore—could in all probability be employed on wulfenite which did not contain such a large percentage of barite as this material. As the analyses indicated, it contained 18.56 per cent $BaSO_4$ and besides requiring the presence of caustic soda as a flux, enough soda ash must be added to convert the sulphate to carbonate so that barium carbonate would be left behind with the residue and prevent barium hydroxide from going through into the filtrate. In every run made, analyses of the leached liquors containing the sodium molybdate gave no test for vanadium, iron, barium or phosphorus; and these were found left behind with the insoluble residues. Practically all the silica remained in the residue.

PRECIPITATION OF MOLYBDENUM AS CALCIUM MOLYBDATE

As previously explained, the precipitation of molybdenum from an alkali leach solution as calcium molybdate offers the following advantages:

1. Under the proper conditions a complete precipitation can be made.
2. $CaMoO_4$ may be used in the manufacture of special alloy steels.
3. $CaMoO_4$ may be used in the electric furnace in manufacture of ferro-alloys.
4. $CaMoO_4$ may be used for the preparation of purified chemical salts.

The precipitation experiments on calcium molybdate were made on 100 cc. aliquot portions of solutions which were obtained from the previous fusion runs as indicated in Tables III and IV. The methods of preparing these solutions from the fusions have been previously described.

TABLE III

Precipitation With Large Excess of $CaCl_2$ Solution at Room Temperature

Leached Solution From Run No.	Mo Extracted by Leach	Grams Mo per Liter of Solution	Per Cent Mo Precipitated as $CaMoO_4$	Remarks
1	85.09	1.35	47.30	Solution stood over night before filtering.
2	83.10	1.32	49.60	Solution stood over night before filtering.
3	89.30	1.41	50.90	Solution stood over night before filtering.
12	91.05	5.96	40.03	Solution stood over night before filtering.
13	93.90	2.88	60.00	Solution stood over night before filtering.

The above figures clearly indicate that molybdenum cannot be precipitated completely at room temperature by calcium chloride solution, even if employed in large excess and allowed to stand several hours. The best precipitation found was 60 per cent, that of run No. 13, given above. To be certain that an excess of calcium chloride had been used the filtrate from the calcium molybdate precipitate was tested for the presence of calcium salts.

TABLE IV

Precipitation by Slaked Lime Emulsion at Room Temperature

Leached Solution From Run No.	Mo Extracted by Leach	Grams Mo per Liter of Solution	Per Cent Mo Precipitated as $CaMoO_4$	Remarks
5	97.4	6.18	8.9	Excess amount of slaked lime added to bottle—shaken 6 hr.
6	98.2	6.23	7.8	Excess amount of slaked lime added to bottle—shaken 6 hr.
11	99.1	6.28	8.4	Excess amount of slaked lime added to bottle—shaken 6 hr.

As indicated above, the use of slaked lime with prolonged agitation gave at the best less than 9 per cent precipitation of molybdenum.[8] Attempts to use a large excess of $CaOCl_2$, bleaching powder solution, at room temperature on duplicate solutions of runs 5, 6 and 11, gave respectively 73.1, 77.9 and 66.9 per cent molybdenum precipitated; indicating that the complete precipitation did not depend upon the oxidized state of the molybdenum in the leached liquors. Bromine was tried as an oxidizing agent, followed by excess calcium chloride at room temperature, without improving the results. However, on boiling these solutions the molybdenum was completely precipitated.

---

[8] Experiments performed in this laboratory for precipitating vanadium in the presence of molybdenum were successful by using slaked lime in a boiling solution. The alkalinity of the liquor was found to be increased by this treatment—a fact which assists in keeping molybdenum in solution. No special alkalinity was necessary or desirable for the precipitation of the vanadium, as some of the liquors after precipitation of the vanadium varied in alkalinity from an equivalent of 27.4 to 78.4 g. of sodium hydroxide per liter. See Conley, J. C., "A Proposed Metallurgical Process for the Treatment of Vanadinite for the Recovery of Lead and Vanadium," CHEM. & MET. ENG., vol. 20, No. 10, p. 514.

TABLE V

Precipitation With Excess $CaCl_2$ Followed by Boiling the Solution

Leached Solution From Run No.	Mo Extracted by Leach	Conc. of Mo per Liter	Per Cent Mo Precipitated as $CaMoO_4$	Remarks
5	97.4	6.18	99.8	Solution boiled until precipitate formed became granular.
6	98.2	6.23	98.6	Solution boiled until precipitate formed became granular.
11	99.1	6.28	97.2	Solution boiled until precipitate formed became granular.
4	92.7	5.88	98.6	Solution boiled until precipitate formed became granular.
9	96.7	6.12	98.3	Solution boiled until precipitate formed became granular.
10	97.8	6.20	95.6	Solution boiled until precipitate formed became granular.

The fact that in every one of the experiments described over 95 per cent of the molybdenum was precipitated by boiling the solution, after adding calcium chloride, clearly shows the importance of boiling, since the best precipitation, after prolonged standing at room temperature, as given in Table III was only 60 per cent. The necessary amount of calcium chloride needed for complete precipitation has been worked out and will be given in detail.

CONDITIONS FOR PRECIPITATION

The complete precipitation of molybdenum is brought about only in practically neutral solutions. That is, sufficient calcium chloride solution should be added to completely combine with all the carbonate and hydroxyl radicals in solution up to the limits of the solubilities of $CaCO_3$ and $Ca(OH)_2$ which will be precipitated along with the calcium molybdate. When this condition has been satisfied, the resulting solution will be found to be only slightly alkaline, due principally to the small amount of calcium hydroxide still in solution. When this solution has been boiled and agitated vigorously, until the precipitate has become granular in appearance, it will settle quickly and can be easily filtered and washed. Only a trace of molybdenum will be found in the filtrate.

TABLE VI

Alkalinity Tests on Fusion Leached Liquors From 40 Grams Concentrates, and Total Alkali Equivalents

Leached Solution From Run No.	Grams Na_2CO	Equivalent Grams NaOH	Equivalent Grams CaO	Grams CaO for Leached Liquor From 100 G. Concentrate, per Cent
4	27.56	20.80	14.56	36.40
9	30.74	24.20	16.24	40.60
10	41.34	31.20	21.84	54.60

The total alkalinity of leached liquors from 40 g. of wulfenite concentrate obtained in runs 4, 9 and 10 gave total alkali equivalents in grams as indicated in Table VI; the alkalinity being first determined as total Na_2O, and then calculated as the chemical equivalent Na_2CO_3, NaOH and CaO.

From several experiments made, it was found that the amount of $CaCl_2$ solution required, figured in equivalent terms to CaO, to completely precipitate the molybdenum, was only slightly more than the amount of calcium chloride necessary to combine with the hydroxyl and carbonate radicals.

The figures for $CaCl_2$ requirement for precipitating calcium molybdate in an alkaline solution are best found by calculating the strength of the $CaCl_2$ solution in terms of equivalent of CaO, and then adding enough of this solution to correspond to the amount of CaO required, as measured by alkalinity tests illustrated in Table VI, last column. If an excess of $CaCl_2$ solution is added beyond this equivalent CaO requirement, it will remain in the filtrate solution as the chloride. The filtrate from such a precipitation will be found only slightly alkaline, indicating that the alkalinity had been reduced down to the limits allowed by the solubility of calcium hydroxide, and that the molybdenum had been completely precipitated as calcium molybdate.

GRADE OF PRODUCT

The grade of product produced can be governed by neutralizing most of the free alkali before the addition of calcium chloride, in which case less calcium carbonate and hydroxide will be precipitated with the molybdenum. No attempts were, however, made to improve the grade of precipitate obtained, although, aside from the above suggestion, this could be further improved by ignition, which would decompose the hydrate and carbonate of calcium, leaving only calcium molybdate and calcium oxide. A composite sample from the calcium molybdate precipitates obtained in the experiments, dried at 100 deg. C., gave the following analysis:

	Per Cent
CaO	48.15
MoO_3	28.65
Mo	19.10
As	0.17
S	0.48
P	None
Si Fe Al	Trac
HO_2 and CO_2	Not determined

In the original concentrate the ratio of As to Mo was 4.16 to 100, while in the calcium molybdate it is 0.89 to 100, indicating that 78 per cent of the arsenic and all the phophorus had been eliminated in the leaching and precipitation steps in producing calcium molybdate.

The above grade if ignited would produce a product assaying approximately 37 per cent MoO_3. Although the presence of arsenic, phosphorus and sulphur are objectionable in ferro-alloys, the purchasers of ferromolybdenum vary in the penalty for their presence. Some will allow 0.5 per cent total P, S and As, while others will allow only 0.2 per cent. The removal of sulphur can be accomplished by an excess lime charge. A calcium molybdate obtained from a concentrate carrying a smaller amount of barite than was contained in the material experimented on would in all probabilities carry down but a very small percentage of sulphur. Arsenic or phosphorus, if in considerable amount, can be eliminated from the alkali leach liquor as described by Fester,[*] or by adding an oxidizing agent such as NaOCl and then a magnesium salt. Further, some arsenic can be driven off in the electric furnace, and it has been stated that some can be further removed by a refining charge, such as ferric oxide and sodium carbonate. The details for grading up the product and eliminating the small amount of impurities can be worked out for each particular grade of ore treated.

---

[*] *Loc. cit.*

A qualitative run made in a small electric furnace, using a charge of $CaMoO_4$, silica, iron oxide and carbon, gave very promising results. A button of ferromolybdenum was easily made which could be poured from the furnace; the odor of arsenic fumes during the run indicated some volatilization of this element. In making ferromolybdenum, molybdic oxide obtained by roasting molybdenite concentrates was used in crucibles before the introduction of the electric furnace, but the purity of such a roasted product in regard to As, P and S is often inferior to the calcium molybdate made in the foregoing experiments. Besides MoO_3, a ferromolybdenum charge is usually made up of lime, ferric oxide or iron scraps, and some reducing agent like resin, charcoal, coke or aluminum. Silica is oftentimes added for fluxing purposes, and in some cases silicon element has been used as a reducing agent. Calcium molybdate then is an ideal product, since it contains MoO_3 and CaO, which are required in the furnace charge. Ferromolybdenum is now being made directly from molybdenite in the electric furnace with carbon and a large excess of lime along with iron ore or scrap-iron, since the sulphur can be readily slagged as calcium sulphide with a charge of excess lime.

COSTS OF A FUSION PROCESS

The following estimated value of products and cost of chemicals is based upon a 90 per cent recovery of lead metal and molybdenum as calcium molybdate. Although the recoveries for lead and molybdenum on Run 9, Table V, which run will be taken for the basis of calculation, represent an extraction of 96.70 per cent molybdenum and 98.50 per cent recovery of lead, the actual recoveries on a large scale would probably be less.

ESTIMATED VALUE OF PRODUCTS—BASIS ONE TON

44.53% lead, 890.6 lb. (90%), 801.5 lb. at $5 per cwt.	$ 40.08
5.85% Mo,* 317.0 lb. (90%), 285.3 lb. at $1 per lb.	285.30
Total value of products	$325.38

* Molybdenum in the final product as calcium molybdate; price for this element in crude concentrates varies from 75c. to $1 per lb. content.

COST OF CHEMICALS

400 lb. Na_2CO_3, soda ash, at $2 per cwt.	$8.00
1000 lb. NaOH, caustic soda, at $2.65 per cwt.	26.50
100 lb. coal or charcoal, best grade, at $8 per ton	.40
1605 lb. $CaCl_2$†, fused lump, at $25 per ton	20.00
Total cost of chemicals	$54.90

† 1605 lb. $CaCl_2$, equivalent to 812 lb. CaO, amount required to precipitate molybdenum from leached liquors from one ton of fused concentrates.

To the above must be added the cost of mining and milling sufficient ore to produce one ton of concentrates of the grade used in experiments. This is dependent upon so many factors and local conditions that no attempt at an estimate will be made here. Wulfenite ores have been mined and milled for their gold and silver content; consequently, in such cases, wulfenite concentrates could be cheaply produced. This has been well illustrated by the concentrates produced from the Mammoth dump. The ore from the Mammoth mine was originally treated for its free gold content, said to have been $6 to $7 per ton. The dump tailings from these treatments were later concentrated for the wulfenite alone. Horton states that the cost of concentrating wulfenite ores by wet processes is in general comparable to those of treating ores of galena, sphalerite, chalcopyrite, etc., by similar methods. No estimate can be made on the cost of treatment per ton for labor, overhead expenses, depreciation, etc., involved in a chemical plant treating such material, as these items are variable and depend upon local conditions.

It can be said, however, that the demand for molybdenum and the market price will have more to do with the future of wulfenite than any other factors. If the price paid for molybdenum does not warrant a sufficient margin of profit for the extra expense involved in smelting, extracting and recovering the molybdenum as calcium molybdate, then the wulfenite concentrates will be treated for their high lead content alone, or remain unused.

Considering the difference of $270 between the estimated value of products and the cost of chemicals for one ton of concentrates, it appears that there is sufficient margin to take care of all expenses involved in the mining, milling and metallurgical treatment.

In conclusion, the author wishes to express his appreciation and gratitude to Dr. R. B. Moore, superintendent of the Rocky Mountain Station of the U. S. Bureau of Mines, for his valuable suggestions throughout the progress of the work.

Golden, Colo.

Sheet Zinc Stencils

Rolled zinc has desirable characteristics not found in other materials used for making stencils and will have extensive commercial use. This is the gist of a statement made by William L. Muehler of the Patent Die & Stencil Works, New York City. In view of this concern's wide experience in making stencils, the opinion of its representative is regarded as important to the industry.

"Not only is zinc the only material that does not stretch and buckle in continuous use, but it has several other important advantages," says Mr. Buehler. "The oil board used up to now for stencils certainly is low in price but the cutting and making of a paper stencil involves the same skilled work as a stencil made of zinc, and while the former hardly will give 20 to 25 impressions or reproductions a zinc stencil will reproduce 10,000 copies.

"Zinc remains flat indefinitely. Another feature that recommends the use of zinc is the low cost of producing the finished stencil, this metal possessing qualities that permit stamping as many as 1000 stencils in one operation.

"When the manufacturer realizes the economy and value of zinc stencils, as compared with others, it will mean vastly increased demand for this metal. Stencils form the background of nearly every manufactured article—from laces to showcases.

"Right now negotiations are being carried on to supply Japanese producers with zinc stencils for use in stamping silk designs to replace the slower and more expensive hand methods now in vogue."

June Imports and Exports of Tungsten

Imports

Countries	Tungsten Bearing Ore Tons	Tungsten Bearing Ore Value
Argentina	50	$40,000
Chile	136	84,600
Peru	99	50,337
Japan	53	57,780
Total	338	$232,717

Exports

Countries	Tungsten and Ferrotungsten Lb.	Tungsten and Ferrotungsten Value
Canada	48	$1,814
British South Africa	222	532
Total	270	$2,346

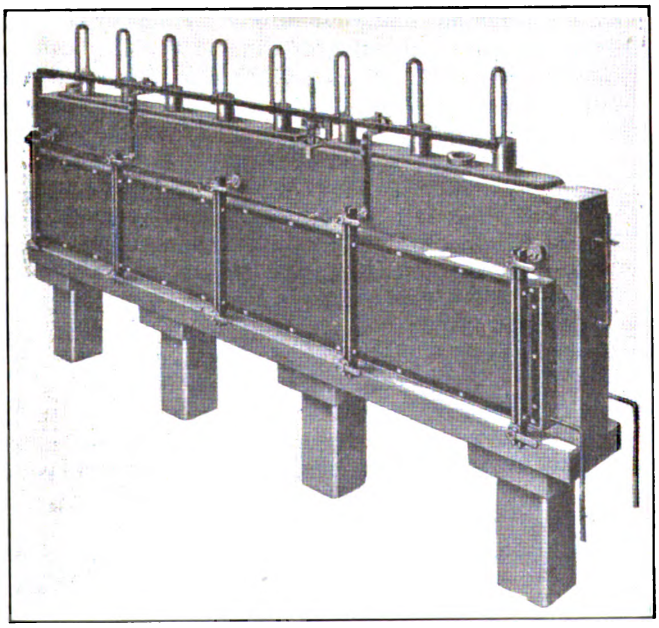
The Allen-Moore Cell in the Pulp and Paper Mill

Description of the Chlorine Bleach Department in the Paper Mill of Dill & Collins Co.—Brine, Cell, Evaporator and Bleach Room—Diaphragm Cell Construction—Summaries of Operating Reports—Present Installations

By F. H. MITCHELL
Chief Chemist, Dill & Collins Co.

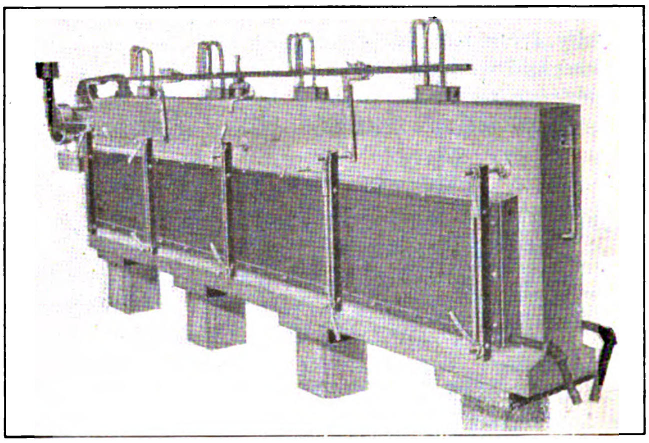
THERE is a decided tendency among progressive pulp and paper manufacturers to control so far as possible the production of their own raw materials, not merely for the purpose of the extra profit, but for the security realized in times of commercial stress and bad railroad conditions, and for securing a uniform product. Many of the large pulp and paper mills manufacture their own bleach electrolytically, not only for the reasons mentioned above, but because, added to the advantages of greater economy and security, there is the benefit of a product which is more active chemically. Many manufacturers claim actual savings in bleach consumption amounting to from 10 to 20 per cent, but the question as to whether a pound of available chlorine in a solution made from commercial bleaching powder is the equal in color produced to a pound of chlorine in electrolytic bleach liquor has been the subject of much discussion. There is, however, no question that the electrolytic bleach solution is quicker in action, and that it is possible to get a solution free from suspended lime, avoiding at the same time the losses which are incidental to getting the bleaching powder into solution. These losses are frequently more serious than is supposed. Actual tests in mills have shown losses from 2 to 20 per cent, the results varying with the quality of the bleach and the carefulness of the men.

In view of this situation, it is believed that a description of the electrolytic bleach plant of the Dill & Collins Co., of Philadelphia, is of interest. Its first cell installation was started in operation on Sept. 16, 1916, and has been in steady, successful operation since that time. In consists of one series of 1200-1500-amp. Allen-Moore cells, which are operated ordinarily at a load of 1200 amp. These cells were designed by the Electron Chemical Co., and the plant and auxiliary equipment were designed by the Moulton Engineering Corporation, both of Portland, Me.



ALLEN-MOORE CELL WITH ROUND LEADING-IN RODS

The accompanying photographs show the different parts of the plant and make detailed description unnecessary. Although but 62 cells were installed at first, a 2-story cell house was built, with a view to further growth, and the second series of cells was installed in 1918, together with 128 cells in a separate cell house, the increase being for the Chemical Warfare Service.

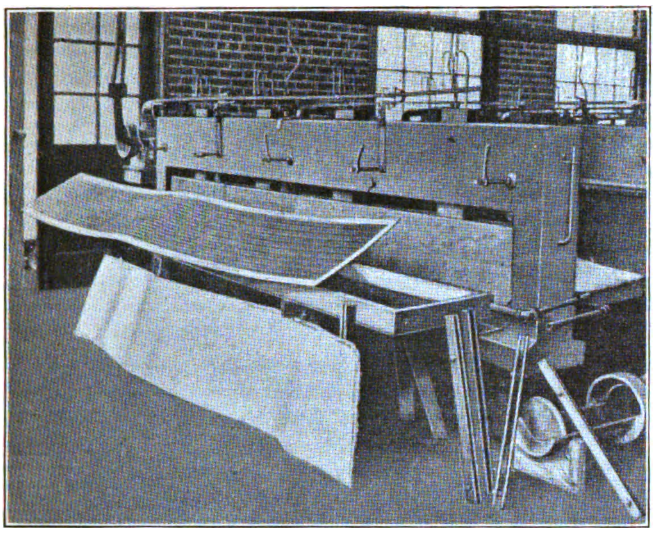


ALLEN-MOORE CELL, WITH RECTANGULAR LEADING-IN RODS

The Dill & Collins bleach plant is naturally divided into the following departments: Brine room, cell room, evaporator room, bleach room and power; and for the sake of clearness these subdivisions will be considered in order.

BRINE ROOM

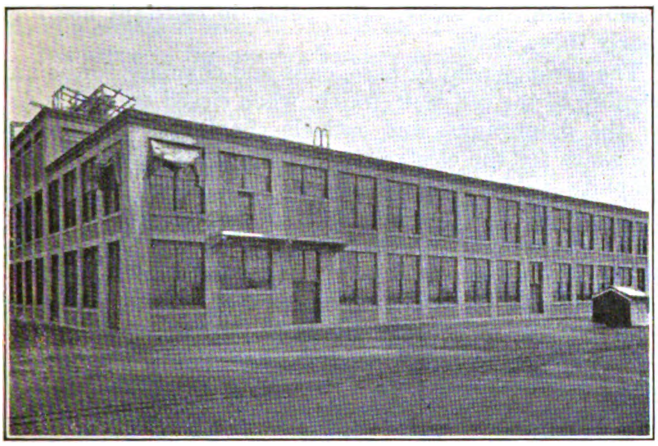
The first essential for the successful operation of a diaphragm cell is a brine freed not only from dirt and insoluble matter, but also from calcium and magnesium compounds. In the Dill & Collins plant the salt is carried by a conveyor to the reinforced concrete saturating column, which is kept full of salt. Water enters at the bottom and overflows at the top, the rate of flow being so regulated that a continuous flow of saturated brine issues from the top of the saturator, whence it flows by gravity to concrete purifying tanks. Here soda ash is added, with air agitation, time being allowed for the precipitation of impurities. The contents of this tank with its impurities in suspension are run through a sand filter, so constructed as to be easily washed and cleaned. The clear brine flows into storage tanks, where hydrochloric acid is added in sufficient amount to neutralize any excess of alkali. The purified brine flows by gravity



SHOWING THE EASE WITH WHICH THE DIAPHRAGM MAY BE CHANGED ON THE ALLEN-MOORE CELL

into a small flow box, the brine being kept at a constant level by a hard rubber float valve, and from this flow box the brine is fed to the cells. Each tank of purified brine holds 12 hours' supply of brine, so that little labor or close attention is required in the brine room.

A good quality of mineral salt (frequently testing 98 per cent NaCl) requires small quantities of soda ash. There is rarely sufficient magnesium present to require special treatment, and the sulphates are seldom present in an amount to necessitate precipitation. Careful tests are made to insure a supply of properly purified brine for the cells.



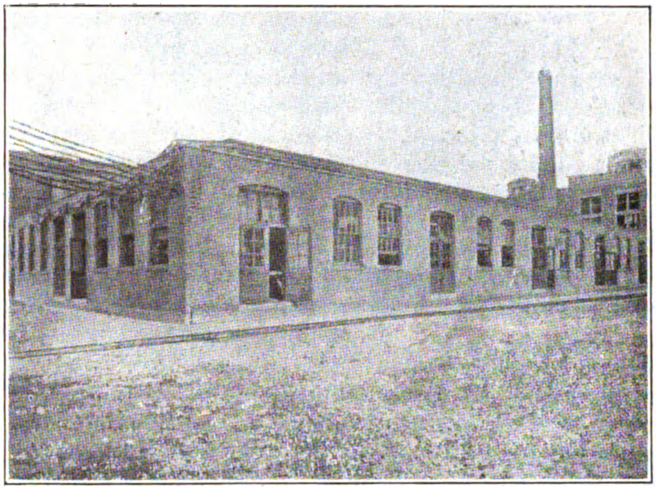
CELL HOUSE NO. 1, DILL & COLLINS CO. PHILADELPHIA, PA.

Cell Room

Each Allen-Moore cell, of which a detailed description follows, carries a float valve operated in a brine well, so that the proper level of electrolyte is maintained. By a simple device, the level can be raised as the diaphragm becomes clogged, to keep the flow at the required rate. The cells are arranged in two rows, electrically connected in series.

The caustic soda effluent flows from the front of the cells into a tile main, and the chlorine from each cell enters a tile main on which a slight vacuum is maintained by a suction fan. The hydrogen gas is discharged into the atmosphere.

The evaporator room is equipped with a double effect Zaremba evaporator, 84-in. pans, with two salt filters under the second effect. The salt caustic liquor to be evaporated contains approximately 120 g. NaOH per liter, and in the two effects is concentrated to a caustic solution of about 46 deg. B. The salt precipitated by the concentration of the liquor is caught in the filters, where it is washed to free it from caustic, and then returned to the brine system. The wash-water, collected in a storage tank, is subsequently returned to the evaporators.



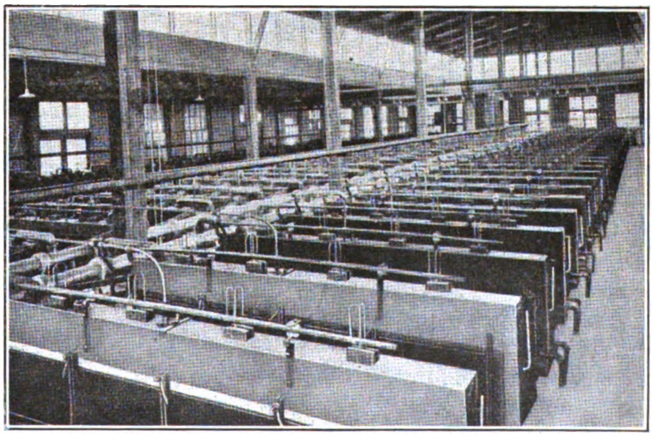
CELL HOUSE NO. 2, DILL & COLLINS CO. PHILADELPHIA, PA.

The concentrated caustic, cooled to permit the deposit of any suspended salt, is used in the pulp mill for cooking the wood, or is sold in liquid form. The finished caustic liquor contains on the average 1½ per cent of salt.

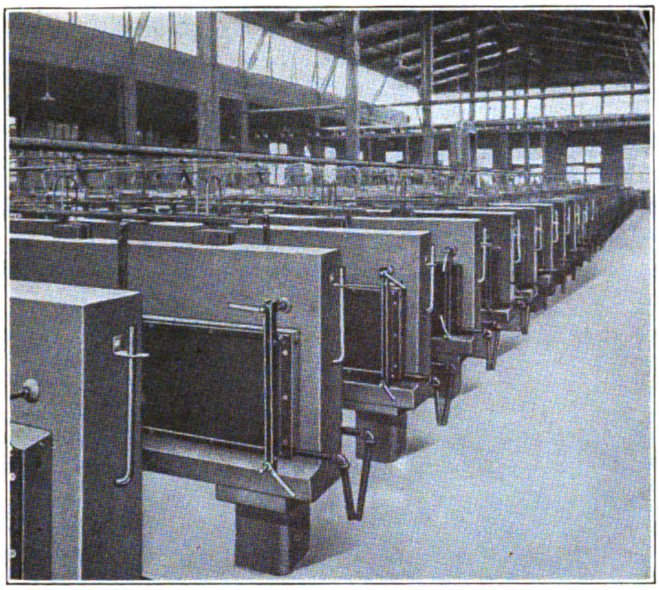
Bleach Room

The tower system is used, the equipment consisting of two concrete towers, each with a partition in the middle, and a series of concrete tanks, with agitators. Each tank holds sufficient milk of lime to make the equivalent of two tons of 35 per cent bleach, in the form of a liquid carrying the equivalent of approximately 80 g. 35 per cent bleaching powder per liter.

The milk of lime in the tank is raised by a centrifugal pump to the top of the towers, down which it falls in a spray, thus absorbing chlorine, which is drawn upward by a fan. The liquor returns to the tank by gravity and is recirculated until it has reached the strength desired. In order to avoid chlorating, an excess of lime is



INTERIOR OF CELL HOUSE, ILLUSTRATING ARRANGEMENT OF CELLS



SECOND INSTALLATION DILL & COLLINS CO.

maintained at all times. When one tank is finished, a second tank of milk of lime is cut in, and the first tank is allowed to settle. After the clear bleach liquor has been decanted to the pulp mill, fresh lime is added to the empty tank and it is ready for a second run. At intervals of ten days or two weeks, depending on the purity of the lime used, the sludge from each tank is washed into the sludge tank, and the residue, consisting of silicates and other insoluble matter, is thrown away.

It is important that the lime be as free as possible from magnesium, since otherwise the bleach will not settle quickly, and it will become increasingly difficult to recirculate the residue. The chlorine apparently does not combine with magnesium until after the calcium has been used up, with the result that there is an accumulation of magnesium which proves disastrous to the keeping qualities of the bleach and to the efficiency of the process. A particularly careful study of the effects of magnesium compounds, as well as iron and manganese, was made by Messrs. Martin Griffin and John Hedalen, the results having been published in the *Journal of the Society of Chemical Industry*, May 31, 1915.

In this installation the current for electrolysis is furnished by generators direct connected to reciprocating engines, and the layout does not call for special description.

Development of Allen-Moore Cell

On account of the interest created by the operation of the Allen-Moore cell, a full description of its development and operation follows:

The Allen-Moore cell is not new, for its inception dates back to 1895, when Hugh K. Moore and Edward A. Allen were co-workers in the first commercial electrochemical plant in the United States, established in Rumford, Me., after the plans of Ernest LeSueur and Charles N. Waite. Indeed, this plant was the starting point of the development of the electrolysis of salt, and most diaphragm cells can be traced to this beginning. The story of the trials experienced in this plant is intensely interesting and should some day be told.

Besides Moore and Allen, above mentioned, were other men whose names have become well known in connection with electrolytic cells. Among them were MacDonald, Barton and others who have been responsible for a great deal of the development which has been made, and the results of the work of the four men above mentioned is seen in practically every diaphragm cell now in successful operation.

The first installation of the Allen-Moore cell in its present form was completed in May, 1912, in the pulp mill of the Jessup & Moore Paper Co., Wilmington, Del., and the plant has been in steady successful operation ever since. The Jessup & Moore Paper Co. made a second installation in 1916, in its mill at Elkton, Maryland.

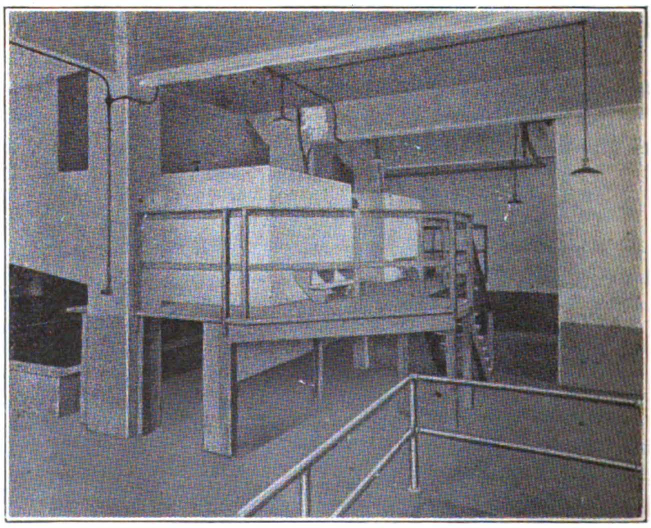
Construction of Cell

The Allen-Moore cell is a porous diaphragm cell with one face only of each diaphragm in contact with the electrolyte and was the first cell to adopt this principle.

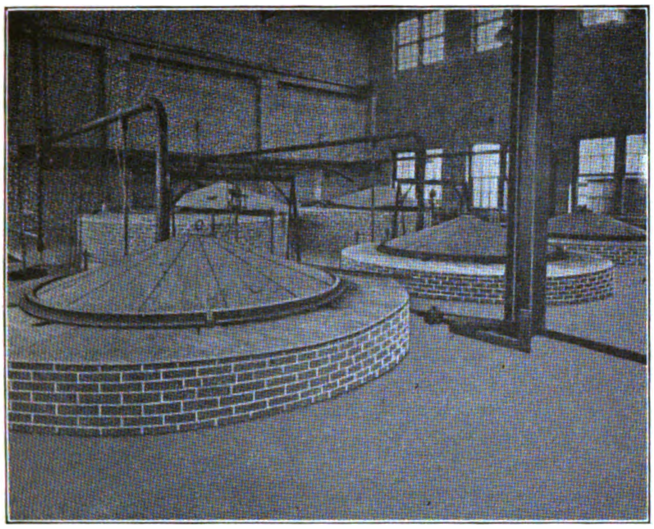
Referring to the illustration, it will be noted that the Allen-Moore cell consists of a rectangular frame of carefully placed reinforced concrete, formed by a base, two ends, and a chamber at the top, this latter being formed by the two side walls, the cell cover, and that portion of the cell ends between the side walls.

It should be realized that this reinforced concrete body serves as an insulating medium to separate the product of the anode compartment from the cathode compartment, and experience has shown that it has decided advantages. It is easily cast and it is so cheap that the total yearly cost is a very small item per ton of products. Moreover, the construction permits the accessibility which is one of the features of the cell, and is one of the factors in the high operating efficiency. The concrete bodies in the Dill & Collins plant are in excellent condition today, after being in constant use for nearly three years.

The arrangement of base, ends and chamber forms an opening in the cell body which, when closed on each side by the diaphragms and cathode chambers, constitutes the space for the electrolyte and the cell anodes. These graphite anodes are disposed in this space in such a manner that their active surfaces oppose the surfaces of the diaphragms which, backed by perforated cathode plates, cover the openings in the cell body. The arrangement of anodes, diaphragms and cathode plates is such that the asbestos diaphragms lie against the cathode plates, while between the diaphragms and active anode surfaces there is a clearance of approximately one-half inch. The electrolyte of saturated brine fills



CONCRETE BRINE TANKS



CAUSTIC POTS

this space between the anodes and diaphragms and covers the anode plates. The anodes extend through the electrolyte chamber, through the gas chamber at the top of the cell and the cell cover, and they are connected to the copper bus bar running along the top of the cell.

The brine is admitted to the anode compartment of the cell from the iron brine main through wrought iron pipes, which are connected with a hard rubber float valve which automatically controls the level of the brine in the well located in the center of each cell and maintains a constant level in the anode chamber.

The brine in the anode chamber comes in contact with the immersed graphite anode and one face of each asbestos diaphragm, of which there are two, one on each side of the anode chamber. The chlorine gas generated in the anode chamber is discharged from each cell into the tile chlorine main at the rear of each bank of cells by means of a tile U with luted connections on both the cell and the chlorine main.

TABLE I—DAILY SUMMARY

24 Hr. Ending at 7 A.M., Jan. 18, 1917

Number of cells running		53
Average voltage at switchboard		200
Average amperes		1,200
Deliveries to Mill:		Total
Pounds, 35 per cent bleach		10,997
Pounds of caustic soda		4,520
Chemical Tests:		
Grams total chlorine per 1,000 cc		......
Grams 35 per cent bleach per 1,000 cc		84.15
Grams free lime		1.72
	Grams per 1,000 cc.	
Caustic Soda:	NaOH	NaCl
Effluent from cells	140	163.
Finished product	713	17.52
Efficiencies:		
Current efficiency, per cent		94.05
Decomposition efficiency, per cent		55.75
E.h.p. per ton of bleach		58.60
Per cent salt recovered		......

The brine, percolating through the permeable asbestos diaphragms, which are supported against each open side of the cell body by means of perforated wrought iron cathode plates, is decomposed and flows down the face of the cathode plates into the channel trough of the steel frame cathode box and deposited there in the form of a salt caustic solution containing about 12 per cent salt and 8 to 10 per cent caustic soda.

As typical of the operation of the cells, a copy of a daily summary of plant operation (Jan. 18, 1917), showing the data kept is given in Table I.

On Feb. 2, 1917, after the plant had been in operation since the preceding September, an official 24-hr. test run was made. Each cell was tested for voltage and current efficiency at 6-hr. intervals, with the following average results:

0.	Cells in operation	54
1.	Active cathode area, sq.ft.	24.12
2.	Amperes per cell, average	1,200
3.	Voltage drop on individual cells (average)	3.6
4.	Current efficiency based on four tests at 6-hr. intervals, on each cell	95.3
5.	Caustic soda per cell, lb	91.7
6.	Voltage drop on cell circuit	202
7.	Saturation of electrolyte, grams NaCl per liter	305
8.	Decomposition efficiency, per cent	55.3

It is of added interest to note that other installations of the Allen-Moore cell are operating with similar good results. Five different plants were the subject of tests not long ago, and the summary of their tests is given in Table II.

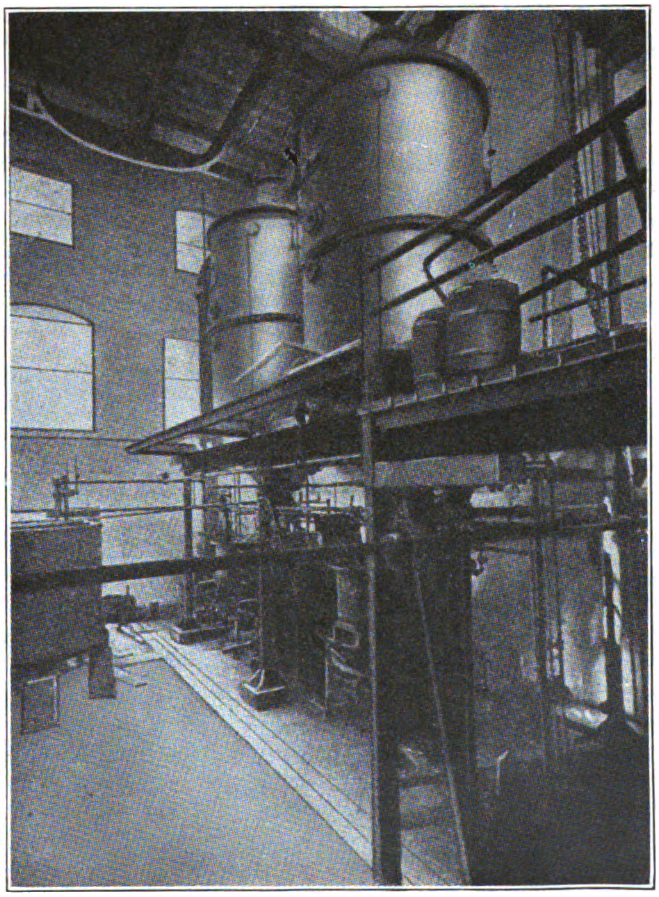
The energy efficiencies in the last column of Table II are derived in the following manner (illustration taken from the data of Plant No. 5):

$$\frac{2.3 \text{ (theoretical voltage)} \times .96 \text{ (current efficiency)} \times 100}{3.7 \text{ (actual voltage)}} = 59.6 \textit{ total} \text{ energy efficiency}$$

It will be noted that, in compiling the results of the tests, a distinction is made between voltage efficiency and total energy efficiency.

The actual average power required for producing 1 lb. of chlorine in the five separate plants considered is, therefore, 1292 kw.-hr.; derived in the following manner:

1344.2 (average amperes) × 0.00290 (lb. theoret-



DOUBLE EFFECT EVAPORATOR WITH SALT FILTERS ical chlorine per ampere hour) × 0.9477 (average current efficiency) = 3.9 lb. chlorine per cell each hour.

1344.2 amperes × 3.55 average voltage per cell = 4.77 kw.

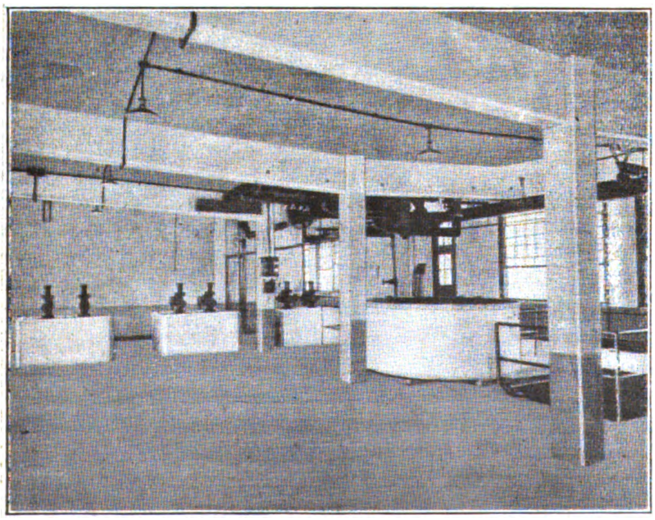
4.77 kw. ÷ 3.9 lb. = 1.292 kw.-hr. per lb. of chlorine.

TABLE II—PLANT TESTS UNDER ACTUAL COMMERCIAL CONDITIONS

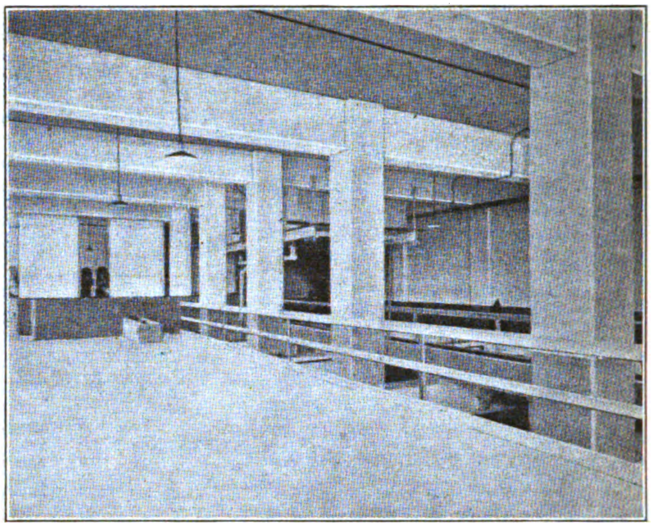
	No. Cells	Average Amp.	Average S. B. Volt.	Voltage Efficiency	Current efficiency per cent	Energy efficiency per cent	Notes
Plant No. 1	31	1362	3.32	69.27	95.00	65.8	Official — Tests run about one month after cells were put in operation.
	31	1226	3.33	69.06	96.47	66.5	
	31	1367	3.45	66.66	94.50	65.0	
	31	1112	3.20	71.87	94.22	67.7	
	31	1308	3.44	66.86	94.10	62.9	
Plant No. 2	21	1606	3.85	59.74	93.07	55.5	Official — Cells in operation about six months—21 tested.
Plant No. 2	64	320	3.80	60.52	93.18	56.4	Unofficial — Some cells set up with carbon and some with graphite.
Plant No. 3	62	1220	3.60	63.88	95.30	60.8	Official — In operation about six months. Specified set-up.
Plant No. 4	29	1410	3.48	66.07	97.60	64.5	Official—32 cells in operation.
Plant No. 4	30	1400	3.67	62.67	93.00	58.3	Figured from actual bleach production and includes absorption losses, etc.
Plant No. 5	63	1400	3.80	60.52	94.80	57.3	Average of seven months' plant operation.
Plant No. 5	70	1400	3.70	62.16	96.00	59.6	General average of operation over period of five years.
Average...	..	1344.2	3.55	64.94	94.77	61.69	

PRODUCTS ARE EXCEEDINGLY PURE

It is obvious to those acquainted with the electrolytic chlorine industry that the products of the Allen-Moore cell must be exceedingly pure. The high current efficiency is sufficient proof of that. The chlorine is entirely free from hydrogen, and contains merely air and small amounts of CO_2. The purity of the caustic is best attested by the long life of evaporator tubes, different effects frequently running more than two years without replacing a tube, and the fact that the caustic is almost entirely prevented from entering the anode compartment is proved from the fact that the anodes, operated at 1200 amp., have an average life of 18 months.



TOPS OF GAS ABSORPTION TOWERS AND LIME-MIXING PLANT MAKING BLEACH LIQUOR



BASE OF GAS ABSORPTION TOWERS

The voltages in the column illustrate the effect of different loads. At 1200 amp., with new diaphragms and new anodes, the voltage is approximately 3.3, increasing slowly to 3.5 or 3.6, when the diaphragm becomes plugged. The maximum voltage under this load is reached at 18 months, when the anodes require replacing. This maximum voltage averages 3.8. Each time the diaphragms are changed the voltage drops. After the first change, at the end of 3 months, the voltage will be nearly the same as with the new cell, but with subsequent change, as the anode wears, and the electrode distance increases, the initial voltage is higher until, at the end of the graphite cycle, a maximum voltage of 3.8 is reached.

A diaphragm life of much longer than three months can be realized, but with a loss of output per kw.-hr. The diaphragm change and the washing of the cell can be accomplished with so little labor (the regular cell attendants taking care of changes) that the increased output makes the use of more asbestos profitable.

The economical operating load of this cell naturally varies with local conditions and with power cost. It will yield almost equally good results in output over a range of from 900 amp. to 1500 amp. In fact recently, in a test at one installation, cells were operated for a period of 6 weeks at loads varying from 1500 to 1900 amp., at a voltage of 4.5, and with a current efficiency of from 90 to 92 per cent.

BLEACH INSTALLATIONS

It is evident from the results secured in the Dill & Collins Co. plant and in others where this type of cell is used, as well as in pulp and paper mills where other types of cells are in successful operation, that the electrolytic manufacture of bleach has long since passed the experimental stage. There is no guesswork as to what a cell or the auxiliary equipment will do. Given definite premises as to cost of power, raw materials and labor, it is possible to fix the production cost of bleach and caustic soda just as accurately as the cost of pulp can be figured.

Following is a list of the pulp and paper mills producing their own bleach:

Mill:	Type of Cell Used
D. M. Bare Paper Co., Roaring Springs, Pa	MacDonald
Brown Co., Berlin, N. H	Allen-Moore and Burgess
Champion Fibre Co., Canton, N. C	Wheeler
Dill & Collins Co., Philadelphia, Pa	Allen-Moore
Eastern Electrochemical Co., South Brewer, Maine	Allen-Moore
Hammerschlag Manufacturing Co., Garfield, N. J	Nelson
The Jessup & Moore Paper Co., Wilmington, Del	Allen-Moore
The Jessup & Moore Paper Co., Elkton, Md	Allen-Moore
Kimberley & Clark, Neenah, Wis	Wheeler
The Miami Paper Co., West Carrollton, Ohio	Allen-Moore
New York & Pennsylvania Co., Johnsonburg, Pa	Hargreave-Bird
Oxford Paper Co., Rumford, Maine	Whiting (mercury)
Penobscot Chemical Fibre Co., Great Works, Maine	Larchar
Riordan Pulp & Paper Co., Ltd., Merritton, Ontario	Allen-Moore
S. D. Warren & Co., Cumberland Mills, Maine	Allen-Moore
West Virginia Pulp & Paper Co., Covington, Va	Hargreave-Bird

Americanization Work in Newark, N. J.

THE sculptor Rodin was a good deal of a prophet. Most of us know his statue "The Thinker"—which is not a white-bearded old man resembling the Rev. Lyman Abbott at all. This thinker is young, he is nearly all muscle and brawn; his brow is low, and he has never thought before. But he is thinking, is thinking now, and he is thinking very hard. With all the world a-quiver with emotion, and history that none of us can understand seething in the making, in the melting-pot before us, everybody tries to think—and the man of muscle and brawn is no exception. He is trying his best, but it is not at all certain whether he will think right or wrong—with the general welfare in view, or toward the red riot of calamity as an end. He will, however, think very much as he is led. The mere presence of a leader may be a determining factor. If, then, the only one present is an I. W. W. organizer, the thinker is likely to follow him, and in the end to range himself among the powers of evil and against all government and order. But if there is any one present to teach him the ideals and ways of American citizenship, the chances are that he will follow such a leader by preference, because most men prefer law and order to chaos. On the other hand, he will not follow any leader who is not in earnest for reasons that are too obvious to need exposition.

NEWARK'S INDUSTRIAL EAST SIDE

The manufacturers of Newark, N. J.—or some of them—have grasped this fact, and, being men of imagination, they have become alive to its significance. Now the purpose of this paper is to tell what has happened in the industrial east side of the city which contains a great many chemical works and a shipbuilding yard which alone employs some 15,000 men. The phenomenon is not peculiar to Newark; doubtless other places have done as well, and some may have done better. But Newark is near by, it is in earnest, and we feel related to it by many ties of chemistry. So let us discuss Newark.

The so-called Ironbound District extends from the Pennsylvania Railroad tracks to the shore of Newark Bay. It covers about three square miles, and some 203 industrial establishments are housed within its boundaries. These employ about 40,000 persons. The total population is 62,189, while those of foreign birth and their children constitute 50,392. There were, according to the last census, 11,807 foreign-born males of voting age, of whom only 3048 had been naturalized. And there were 4588 illiterates of 10 years and over.

In regard to the people who live and work in the Ironbound District, up to a year ago nobody had been very much interested in them. They were not fashionable, nor were they picturesque. Nevertheless, they went right on living, and increasing, and multiplying. And when the thinker of the Ironbound District put his hand over his head and began to think, he was reached by the following organizations:

INFLUENCE OF VARIOUS ORGANIZATIONS

His church and his priest. The purpose of these is to hold him to ethical standards, which is a good thing. The hold, however, is often frail.

The yellow newspapers. These preach the gospel of hate and discontent, usually with a political end in view, or to enlarge their circulation. They prepare the way for I. W. W. propaganda.

The labor unions. With their present passion to unionize everybody and everything, the labor unions have loosened up in their discussion of ideals of betterment, and have substituted problems in economics for consideration among their members in the place of problems in the art of living. This is of no help to the man who is not advanced beyond the stage of elementary thought; in fact it is more likely to upset him than to aid him. It is a great mistake to neglect the art of living as of first consideration, because the subject of economics will begin to manifest itself as soon as proficiency in the art of living has been attained.

RADICALS PREACH REVOLUTION

The I. W. W. and the Left Wing Socialists tell the thinker that he is the slave of Capitalism; that the world is divided into two great hostile camps, of which one gets the rich proceeds of all the harvests and growth, while the other gets only the poor leavin's; and that it is only by a mere fiction of possession that the rich hold their property. The gospel is preached that the only way for the poor man of today to achieve abundance is by revolution; by a regular invasion of the lands and estates of the minority rich by the majority poor. The methods are very much the same, whether expounded by Left Wing Socialists, I. W. W., Bolsheviki, or any other section of the angelic choir; the main differences have to do with who shall lead the crowd, and who shall divide the swag.

There's no profit in getting excited over it. A better way of understanding it is to imagine what we should do—we and our friends—if we were Esthonians or Jugoslavs or Transylvanians, with a language of which the native-born Americans are grossly ignorant. Suppose we worked by the day in the Ironbound District, and that we had difficulty in learning this amazing English language with its ridiculous and impossible pronunciation. Supposing practically nobody on the continent except people from back home could talk to us. Suppose we had no decent books or papers, and were restricted to a pathetic little weakly weekly newspaper, printed in our own language as much for those who can't read as for those who can. We should know only the ugly side of the town, and the chances are we should show only the ugly side of ourselves.

NEWARK MANUFACTURERS TAKE ACTION

It was in October, 1918, that Newark seemed ripe for propaganda and the brotherhood in Russia went so far as to send a number of their slumbering not nor sleeping Bolshevik organizers to establish headquarters right in the Ironbound District, where a large number of Russians live. And it was then that a number of Newark manufacturers got together. It is not recorded who said what, or just who made the next move, but the fact is there was soon developed and organized a concern which is known as "The Ironbound Community and Industrial Branch of the Y. M. C. A. of Newark." The organization has its own officers, and it minds its own business. It gives the impression of being free from that element of the Y. M. C. A. which is addicted to white lawn ties and to prayer meetings and revivals. Mr. A. V. Hamburg of the Hamburg Button Co. is president. Associated with him on the executive board are Messrs. J. H. Bacheller of the Ironbound Trust Co. and F. W. Volk of J. H. Ladew Co. Of the committee of management Mr. Volk is chairman. The vice-chairman is Mr. Eugene Merz of Heller & Merz Co.; Ex-Senator J. H. Bacheller is treasurer; John Campbell of Maher-Flockhart Co. is secretary, while the other members are Messrs. Joseph Doyle of W. S. Rockwell Co., S. C. Coey of Celluloid Co. and W. F. Mullin. A number of these names will probably be familiar to many of our readers. Mr. Edward B. Jacobson, 203 Essex Building, Newark, is the executive secretary. He is an alumnus of the University of Nebraska and of the School of Civics and Philanthropy of Chicago. He has been engaged in social and welfare work for several years in Chicago Stock Yards, in Pittsburgh, and with the du Ponts.

The next step was to organize, which was easy since these men of business wanted to. They didn't want to raise a little Russia right there in Newark; and while they are nearly all ambitious manufacturers they did not want to add *bad Americans* to their products.

MEETINGS HELD IN FACTORIES

Mr. Jacobson secured from the Prudential Life Insurance Co. and the New Jersey Law School some thirty young men who were soon trained to teach English and citizenship. They were volunteers, and they bit right into the work. Another thing was to visit the priests of the various foreign-language churches, mostly of the Roman and Greek Catholic persuasion, and these, to a man, were hearty in their co-operation. At this time Mr. R. I. Vail, who has had some fourteen years of experience in Americanization work, was added to the supervisory staff. Then meetings began all over—in factories, sometimes as part of the lunch hour, and sometimes after closing; sometimes on paid time, and sometimes on the men's own time; they work it every way, but principally in two directions: teaching English through the Peter Roberts system, and citizenship. The English classes go right on, with new ones forming constantly. In the meantime various foremen in factories have taken the teaching course, and they are now teaching also. The citizenship meetings, classes and lectures disclosed the remarkable phenomenon that Bolshevism, I. W. W. propaganda and the like were the only ideas that theretofore had been propounded. The idea of representative government appealed to them as soon as they could understand, and the appeal of revolutionary ideas lost force as soon as others were placed in competition. To those who love system and order the appeal of revolution and disorder is not strong.

Illustrated talks on government were introduced, and these have been carried on in various languages. Open forums are held, and at one of them lately, attended by 600 Russians, the speaker of the evening, who had recently returned from Russia, was invited to come again, to explain more fully the differences between the American ideals of democracy and those of the Russian Bolshevists. Within the short time the work has been under way over 630 men have been aided in getting out their naturalization papers.

GRAND PAGEANT ON MEMORIAL DAY

Then on Memorial Day there was a grand pageant in which 10,000 people participated in East Side Park. There was a Parade of All Nations to Four Corners and back, and a silver loving cup given to the best appearing division. There were tableaux, and pledging allegiance to the flag, an address by the Mayor, and folk dances, with a silver loving cup as prize for the best dancers. Then followed addresses in English, Russian, Polish, Italian, Lithuanian and Czechoslovakian. That may not sound important, but in point of fact it was so; it was the first participation of those new citizens in a public affair. It had more meaning in it than any other Decoration Day parade that we know of.

It was the privilege of the writer to visit two classes in English at the Heller & Merz works. They began after the evening whistle blew, were held on men's time, and the energy and enthusiasm of the pupils were no less than inspiring. We need not be afraid of such men. They are workers, not idlers. The loose-lipped pervert and the swaggering high-class idiot were not among them. We may well welcome them as citizens. Their situation, however, is difficult. They do not yet know the language of the country, nor are they familiar with its customs. Few of them know anybody who has got rich, except by sight. Heretofore nobody has been interested in them except their own little group, and it has been difficult to determine where to seek good advice, or to know which advice was meant for the recipient's good, and which for the adviser's own profit. In the old days things were different, and a man could know his boss. Now that concerns have grown so big a man hardly knows his foreman.

This reminds us of another department about to be started in the Ironbound Community Service. It is a foremen's organization of different factories and industries. Who would have thought of that twenty years ago? Through this we may learn of exceptional talent occasionally. And the long day's work may be made into a thing desired.

GOOD AMERICANS THERE IN THE MAKING

The Ironbound District of Newark is not a fashionable quarter. But we believe there are Americans in the making there who may in time prove much more illumined leaders of us all than some of the most puffed up and vainglorious Senators in Washington today. The men are in earnest, the teachers are in earnest, the employers are in earnest, and social conditions have greatly improved since this movement has been under way. Maybe some day in addition to the reputation for high-class merchandise which the city of Newark enjoys there may be added the tradition that the men that came from Newark are upstanding and dependable; that they do not break faith; and that they bring with them ideals of fairness to all and of liberty through justice.

Commercial Testing of Metallurgical Electric Furnaces

A Comprehensive Outline of Methods to Be Used in Testing Metallurgical Electric Furnaces—Interpretation of the Collected Data, Summarizing the Results, Conclusions as to Suitability, Reliability, Production, Cost of Operation and Maintenance and Other Considerations

BY H. M. ST. JOHN

DURING the past three years there has been a notable increase in the use of electric furnaces as applied to metallurgical processes, and the question of electric-furnace design and operation for various metallurgical purposes has become one of absorbing interest to many who previously had little knowledge of the subject. This development has not been without its publicity, but, among the valuable contributions which have filled so much space in the technical press, one searches in vain for a comprehensive discussion of suitable and adequate methods for use in testing furnaces of this type, for the purpose of determining their real economic value under any given set of conditions.

It is not the intention of the writer to attempt, in this article, the presentation of an authoritative and final exposition of testing methods, which might be accepted as a complete and trustworthy guide for use under any and all conditions. Desirable as such a conclusive statement of methods may be, it can result only from an open discussion, from different angles and by men of varied experiences, each of whom can contribute something not common to the experience of others. It is partly in the hope of arousing such a discussion that this article is written. If, at the same time, the results of the writer's experience prove to be of any value to others faced by similar problems, his purpose will have been completely served.

THREE FACTORS TO BE CONSIDERED

The consideration of an electric-furnace installation for use in a metallurgical plant naturally resolves itself into three parts. First, it is necessary to select for trial some type of furnace likely to give the desired results in the work of that particular plant. Second, the furnace chosen must be subjected to an adequate test, to determine the quality of its performance as compared with other types of equipment, electric or otherwise, which are suitable for use on the same work. Finally, the furnace, once accepted as satisfactory, must be fitted into its place in the manufacturing scheme of the plant by the development and use of suitable operating methods, designed to secure a maximum of operating economy with a minimum of expensive supervision.

The question of initial selection of the furnace, and that of development of operating methods, are reserved for later discussion. Let us confine ourselves here to a consideration of electric-furnace testing and the interpretation of test results, principally for the reason that this phase of the matter has so often been neglected, sometimes with serious results.

In dealing with the commercial testing of electric furnaces, as differentiated from laboratory testing incidental to their experimental development, it is necessary to remember that, as a rule, at least three parties have a vital interest in the successful use of the furnace. These are the seller of the furnace, the prospective user, and the company which is to supply electric power for its use, or, if the manufacturing plant generates its own power, its power engineer may be considered as the third party. Each of these has important interests which must be satisfied, and no furnace test is complete which does not supply the necessary data to meet their varying requirements.

FAILURES SOMETIMES DUE TO LACK OF CO-OPERATION

The failure of certain furnace installations can be traced directly to a lack of co-operation among these three interested parties. In general, each has certain information and experience pertaining primarily to his own sphere of operations but having an important bearing, nevertheless, on the successful use of the furnace. The seller is familiar with the characteristics of his furnace, but is not likely to have complete knowledge of the requirements peculiar to the plant in which the furnace is to be installed, nor does he always realize the effect which these requirements will have upon the operation of the furnace. The manufacturer understands the necessities of his plant, but as a rule he is not familiar with electric-furnace operation and often does not understand that he can profitably modify the practice which he has previously adopted as suitable for use in connection with fuel-fired furnaces, in order that he may enjoy, to the fullest extent, the advantages of the electric furnace. Even if he is convinced that the methods in use in his plant should, so far as practicable, be made to conform with electric-furnace requirements, he himself, and his technical staff, are handicapped by lack of experience with electric-furnace operating methods. Neither the seller of the furnace nor the manufacturer who is to make use of it is likely to be aware of the special problems of electrical generation and distribution which must be solved in order that the power company may supply satisfactory service for the furnace at a reasonable cost, nor can they easily calculate what the cost of power will be under given conditions.

CENTRAL-STATION COMPANY OF ASSISTANCE

With respect to these points, the central-station company occupies a unique position in that its true interests are identical with those of both the seller and the buyer, while at the same time it usually has at its disposal information dealing with the application of electric furnaces which is more general and comprehensive—if less detailed and specific—in its nature than is readily available to either of the other parties. As a result the power company is in a position to render a great deal of assistance in the development and proper application of electric furnaces in the territory which it serves, and is the natural arbiter in case of misunderstanding or dispute concerning the nature and conduct of acceptance tests. It has, of course, its own interests to guard, but these do not in any sense conflict with those of the furnace manufacturer and the buyer, who may be termed the "mutual customer."

General Outline of the Test

The ultimate object of a commercial or acceptance test of an electric furnace is to determine the quality of its performance with respect to suitability, reliability and overall economy. With any furnace these factors vary widely, depending upon the conditions of its use, and it is accordingly necessary to consider them afresh in the case of each new installation.

In order to prove its suitability in any given field, the furnace must turn out a product of at least as high a quality as that ordinarily produced by the industry, using the raw materials and operating under the conditions which the general requirements of the industry impose. Its performance must be at least as good, in all essential respects, as that of equipment already in use in the same plant or in similar plants.

Having met the requirements of suitability by showing a high quality of performance when at its best, the furnace must further demonstrate its ability to maintain its favorable performance, day after day, under average working conditions. Sustained mediocrity is preferable to intermittent perfection. A furnace which requires delicate handling, frequent repairs and expensive supervision is not a satisfactory industrial tool.

Finally, the electric furnace, in order to make a place for itself, must show that it has, in addition to suitability and reliability, economic advantages which will make its use a money-saving, money-earning proposition. It must not merely be as good as other equipment used for the same purpose; it must be better. It must either turn out as good a product more cheaply, a better one at the same cost, use cheaper raw materials, require less labor, show a substantially greater production for the same capital investment, or in some equally important way prove its economic superiority.

QUESTION TO BE ANSWERED

The electric-furnace test is expected to furnish the data by means of which these factors can be evaluated in dollars and cents, and an overall summation obtained for comparison with other furnaces. Other electric furnaces in other plants have proved that they possess some one or more of these advantages, and have consequently continued in successful operation; the question is: Can *this* furnace show that it has an economic right to exist in *this* plant?

The answer to this question lies in a thoroughgoing analysis of the furnace performance as related to plant operation, followed by correct interpretation of the results of analysis. It is the purpose here to discuss how this analysis can best be made and what form the interpretation should take, confining our attention to the various types of furnaces employed in the melting and refining of steel and non-ferrous alloys. These are the fields in which electric-furnace development is experiencing its most rapid growth and in which the practice of adequate methods of test is at present most needed.

In this class of work the data to be obtained from a comprehensive furnace test may be listed under the following heads:

1. Reliability and production.
2. Electrical characteristics.
3. Metallurgical characteristics.
4. Cost of operation.
5. Cost of maintenance.
6. Miscellaneous considerations.

The electric-furnace test proper naturally resolves itself itself into three parts: the preliminary test, the intensive test, and the operating test. These must sometimes be supplemented by various special tests to determine some one factor which cannot readily be studied under ordinary operating conditions. These three tests are of nearly equal importance, and no one of them can be omitted without seriously impairing the value of the test as a whole.

The Preliminary Test

DETERMINING THE FURNACE'S SUITABILITY FOR THE WORK

The preliminary test covers the period from the time current is first turned on until the furnace is operating smoothly under regular plant conditions. This period will ordinarily include from one to two weeks, although it may be much more prolonged. During this time what has been termed the suitability of the furnace will be determined. If it is entirely unsuitable for the work, this fact will at once become apparent. If the lack of suitability is inherent and ineradicable, the furnace test is at an end and the furnace is rejected without further ado. If, on the other hand, it seems probable that the difficulty can be remedied by minor changes of design, the test may be continued, depending principally upon how far the furnace user is willing to co-operate with the seller in carrying on what must really be classed as additional development work of an experimental nature. In any event, the intensive portion of the test cannot be started until the furnace is operating smoothly under practical rather than experimental conditions.

If no serious defects develop in the furnace itself the period of the preliminary test is utilized in testing the auxiliary equipment and in co-ordinating the operation of the furnace with that of the plant as a whole. Defects in auxiliary equipment, such as motors, regulating devices, charging and conveying mechanisms, are frequently troublesome, but can usually be remedied without serious difficulty. These must all be in proper condition before the furnace can be given a fair trial. The facilities for bringing metal to the furnace and for removing molten metal after pouring must be at least as good as those in use with other furnaces in the same plant. In fact, it is often true that electric-furnace operation justifies more complete and efficient equipment of this nature than could profitably be used with other furnaces.

CO-ORDINATION IMPORTANT

Co-ordination of the furnace with other parts of the plant is no less important and often more difficult in a long-established plant than perfecting the operation of the furnace itself. Elimination of waste time, always of importance, is absolutely essential to the successful use of the electric furnace. Everything must be ready when it is needed, and every man, from the furnace operator to the laborer in the pouring gang, must know exactly what is required of him and be prepared to carry through his part immediately, whenever his services are needed. The electric furnace cannot be fairly tested until the operator, the weighmaster, the boss of the pouring gang and the foreman of the casting shop are thoroughly familiar with this requirement and ready to comply with it.

The time occupied by the preliminary test can also be utilized to good advantage by those who are to take an active part in the test, in familiarizing themselves with the conditions which must be met. The operator may already be familiar with the characteristics of his furnace, but he must also learn the characteristics of the metal which the furnace is to melt, and the specific requirements as to pouring temperature, etc., which the furnace must satisfy. The man who is to supervise the test, and his assistants, must acquaint themselves with the nature of the furnace and other equipment and must obtain a good working knowledge of the manufacturing methods in use in the plant in so far as these have a bearing on the operation of the furnace. If these men are not members of the plant organization, they should become sufficiently familiar with it and its personnel to insure full and willing co-operation at times when such co-operation is of vital importance. Under such circumstances personal acquaintanceship and good feeling are essential to success.

The data taken during the preliminary test are of minor importance and should consist of an approximate determination of the electrical characteristics of the furnace and of such general observations as are required in order to co-ordinate the furnace with the rest of the plant. This includes a determination of the approximate time required for the melting operation, for the charging, pulling the slag, pouring, etc., the weight and mixture of charge which gives best results, and other factors upon which the operation of the furnace directly depends.

Intensive and Operating Tests

DETERMINING BEST PERFORMANCE

The object of the intensive test is to determine the best possible performance of which the furnace is capable under the stipulated manufacturing conditions. A careful determination is made of all the factors which enter into the reliability and economy of furnace operation. This test normally requires from three days to a week, during which time skillful supervision and trained observation are necessary. It consists of a brief operating test, supplemented by such special tests as may be required, conducted in such a way as to establish standards of performance, with which the operation of the furnace later on, under more practical conditions, may be compared. The intensive test eliminates the personal equation of the human element so far as possible, and furnishes data which, if correctly interpreted, will demonstrate the virtues and defects of the furnace itself, as distinct from the men who are using it and the other foundry equipment with which it is used. Frequently these data will also point the way to improvement in design and modification of operating methods calculated to make of the furnace a more satisfactory foundry tool.

OPERATING TEST UNDER ROUTINE CONDITIONS

When the intensive test has been completed, unless the furnace has already exhibited defects so serious as to make its further use undesirable, it should be put to work as a regular part of the plant equipment and operated steadily in a routine manner for at least a month. This constitutes the operating test, the final stage of the acceptance test. During this period the taking of data continues, but operating supervision should be limited to the degree which would ordinarily be employed if the furnace already occupied an accepted place in the foundry. The operating methods used should be based on the experience obtained during the preliminary and intensive tests.

The data taken during the operating test should include all points which have a direct bearing on the cost of production, but need not be so exact for each heat turned out as is desirable during the intensive test. The weight of metal melted and the kilowatt-hour consumption should be taken for each heat, as well as the time required for the melting operation; the metal lost in spillings and in the slag should be determined for the test as a whole, and, together with the weight of castings obtained, compared with the total weight of metal charged during the same period; the quality of metal and the percentage of defective castings, with the nature of the defects, should be carefully noted; irregularities in operation should be noted and traced to their sources; finally, the cost of maintenance should be determined as completely as is possible in such a comparatively short period of time.

COMPARISON OF FIGURES

At the conclusion of the operating test the results obtained under regular manufacturing conditions should be compared with the more ideal figures taken during the intensive test, for the purpose of establishing what may be called the best practical performance of the furnace. This comparison is also useful in pointing out defects in furnace construction or operation which may perhaps be remedied. It is now possible to predict, with a fair degree of precision, what may be expected of the furnace as a tool, and to determine its status as compared with other types of melting equipment, for which accurate data may be at hand. On the basis of this prediction the furnace may be definitely accepted, tentatively accepted for further development and test—if circumstances seem to justify such a course—or definitely rejected.

The series of tests described may seem to some unnecessarily comprehensive and detailed, but in the procedure outlined it is merely proposed to carry out, carefully and according to a definite plan, work which is more often done aimlessly or without due consideration. It is only by careful and thorough test that one may learn in a relatively short time what the electric furnace will do in actual practice. It is far better to obtain reliable information on this point before one pays for the furnace than to learn later on, from a perusal of the yearly balance sheet, that the furnace has been unprofitable.

Testing Equipment

SELECTION OF MEASURING DEVICES IMPORTANT

The selection and use of electric meters and other measuring devices is a matter of considerable importance in electric furnace testing. The permanent switchboard equipment of every electric furnace should include, at the very least, a watt-hour meter, to show the energy consumption of the furnace, and a voltmeter, to indicate the voltage across the furnace, if the latter is of either the arc or resistance type. In the case of the induction furnace the use of an ammeter, to show the current flowing in the primary circuit of the furnace, is perhaps of more importance. Ammeters are useful, in any case, especially with a 2-phase or 3-phase furnace, where it is desirable to detect any unbalancing of phases which may exist. An indicating wattmeter in the primary circuit enables the operator to tell at a glance what his power input is, and is of distinct assistance to him. The use of a power-factor meter is advisable in the operation of any furnace which tends to have a low power factor, in order that the operator may be able at all times to keep the power factor at the highest practicable point.

RECORDING INSTRUMENTS A VALUABLE CHECK

Recording instruments are valuable as a check on the operator, especially in case of 24-hr. operation, where the plant superintendent seldom sees the night operator. A glance at the instrument chart will show the time taken for each heat and the characteristics of the load, while comparison of the chart with the operator's report will indicate the cause of trouble, if trouble exists. Not more than one recording instrument need be used for this purpose, usually either a wattmeter or a voltmeter, or, in the case of the induction furnace, an ammeter rather than a voltmeter.

For purely test purposes a voltmeter should also be used on the primary side of the furnace transformer, since a comparison between supply voltage and furnace voltage is desirable, particularly with arc furnaces. If the permanent equipment of the furnace does not include a power-factor meter, it is necessary either to provide such a meter during the test or to add a wattmeter and ammeter to the voltmeter already specified for the primary circuit, in order that the power factor of that circuit may be calculated.

CURRENT AND POTENTIAL TRANSFORMERS

These instruments must, of course, all be connected through suitable current and potential transformers. In the case of the watt-hour meter the ratios of these instrument transformers must be such that readings as small as one kilowatt-hour can be made with a fair degree of accuracy. It is only by a study of the energy consumption of the furnace during heats made at different times of day and under varying conditions that the highest economy of furnace operation can be attained. The watt-hour meter used by the power-supply company—upon the monthly readings of which the power bills are based—cannot ordinarily be read with sufficient exactness to be suitable for test purposes.

The temperature of the molten metal delivered by the furnace is of great importance, and, during the test period at least, should be known as exactly as possible. The metal should, of course, always be heated to the temperature required by the casting shop, but additional superheat is expensive and should be avoided, because the added energy required to produce even a few degrees of unnecessary superheat is relatively large. In melting brass or other alloys which contain a volatile constituent, unnecessary superheat also means unnecessary loss of metal and added expense on that score. Energy consumption and metal loss figures cannot be properly interpreted unless one knows the temperature at which each heat is poured.

The temperature of molten alloys up to 1250 or 1300 deg. C. (2280 to 2370 deg. F.) can be measured by means of a base-metal thermocouple, and such an instrument should be provided for this work. In the present state of the art the constant use of a thermocouple for registering molten metal temperatures in regular practice is often too expensive and inconvenient, but for test purposes the trouble and expense involved are well justified. Under these conditions the ordinary steel protecting tube cannot well be used, since it is rapidly attacked by the molten alloy, and also because its thermal lag results in a slow reading. A bare couple gives rapid results which are fairly accurate if the determination is made with care. The couple is consumed rather rapidly by the action of the molten metal and its use is, therefore, somewhat expensive. It is not necessary to maintain the weld at the tip of the couple, since, if the elements are not allowed to separate widely, sufficiently good contact is made through the molten metal. Special protecting tubes may also be used, which, while rather expensive and having a tendency to retard the reading, are suitable for test purposes. It is usually more convenient to measure the temperature of the metal after it has been poured into the ladle rather than to attempt measurements of metal still in the furnace.

In the case of steel or other metals which are poured above 1300 deg. C. (2372 deg. F.) the problem of temperature measurement is an extremely difficult one, since the use of a thermocouple immersed in the metal is no longer practical. The use of an optical pyrometer, provided with a special temperature scale calibrated for the light emissivity of molten iron and steel, has been proposed, but such a pyrometer is very expensive and its value for this purpose limited. By installing a thermocouple permanently in some part of the wall or roof of the furnace it is possible to get relative temperatures which may be found useful. This practice is also advisable in the case of certain resistance furnaces which have a high capacity for absorbed heat, not so much for the purpose of estimating metal temperatures, but in order to limit the rate of heat input to a safe value.

The whole question of temperature measurement and methods is one which merits a much more detailed discussion than can be given it here. Its importance in metallurgical tests of all kinds can hardly be overestimated and it should be given careful study by the engineer who conducts such work.

OTHER INSTRUMENTS NEEDED

Other instruments needed for the electric furnace test are thermometers, stopwatches and a water meter, although the last named, while useful for determining the amount of water used for cooling purposes and for regulating the rate of water flow, can be dispensed with. Unless it is used, however, the amount of heat dissipated in the cooling water can be found only by weighing the quantity of water which passes through the cooling system in a specified time. A thermometer should be used to measure the temperature of the water supply, another to measure the temperature of the water as it leaves the furnace. The furnace transformer should be equipped with a thermometer to measure the temperature of its oil, and the room temperature in the immediate neighborhood of the transformer should also be taken. Stopwatches can be used to advantage in measuring various time intervals during furnace operation.

All instruments to be used during the test should be calibrated and tested very thoroughly, as inaccurate meters betray the confidence of the user and sometimes lead to serious errors.

Reliability and Production

Reliability and rate of production are closely linked, although the latter also depends, in marked degree, on the power input and thermal efficiency of the furnace. In judging reliability it is very important to make a distinction between delays in operation due to failure of the furnace and delays due to lack of co-ordination between the furnace and other parts of the foundry. Interruptions in the continuity of furnace operation resulting from a failure of the weighmaster's department, or the casting shop, to meet the furnace requirements on schedule time are largely avoidable and should not be charged against the furnace. A distinction should also be made between unavoidable delays, resulting from defects inherent in the design of the furnace itself, and interruptions due to defective operation of auxiliary apparatus, such as tilting mechanism, electrode-operating devices, etc. These, together with such loss of time as may be due to lack of skill on the part of the operator, are also, for the most part, avoidable.

THE FURNACE LOG

Most of the information upon which conclusions with respect to reliability and production are to be based is contained in the furnace log. This log should be kept carefully throughout, from the time power is first turned on until the end of the operating test. In it should be noted the time interval required for each principal phase of the furnace operation, together with all irregularities and their cause, and such other happenings as may seem to have a bearing upon the performance of the furnace. In tabulating and interpreting the mass of data which must be digested, after the final test has been completed, it is often possible to explain puzzling and seemingly contradictory results by a glance at the log for the particular heat in question. The principal data for each heat should be kept in an orderly manner on a separate sheet, and, for the sake of convenience, should be unaccompanied by remarks or other extraneous matter.

SAMPLE OF A LOG

Following is given, as an example, a log for two consecutive heats of an arc furnace melting a copper alloy:

HEAT NO. 10

Time A.M.	Remarks
3:25	Started charging
3:30	Power on
3:41	Power off to add new electrode
4:15	Power on
4:45	Power off to remove slag, metal ready
4:55	Started pouring
5:00	Finished pouring

HEAT NO. 11

Time A.M.	Remarks
5:00	Started charging
5:10	Power on
5:20	Power off to adjust electrode
5:23	Power on and off immediately, broken electrode, new one added
5:28	Power on
5:32	Power off to adjust electrode
5:34	Power on
6:05	Power off because of changing shifts
6:12	Power on
6:14	Power off to remove slag
6:19	Power on
6:25	Power off, started pouring; spilled quite a bit in pouring
6:30	Finished pouring

The conduct of both of these heats is open to criticism, which, however, should not be directed toward the furnace. In the first heat 34 minutes was required to add a new electrode section, although the normal time for this operation was not more than 5 minutes, as was the case during the second heat. The man keeping the log neglected to note down the reason for the abnormal delay in the first case, a regrettable omission, as such delays are serious and should always be traced to their source. The loss of 7 minutes because of changing shifts was inexcusable. Such losses of time look small, when considered separately, but loom large when taken in the aggregate. On the day when these two heats were made, the total of lost time, not in any way attributable to the furnace or its auxiliary equipment, amounted to 1 hour and 20 minutes, ample time for another heat to have been made. Examination of the data sheet for these heats showed that in each case the energy consumption was abnormally high, which was readily explained by the fact that the time consumed was at least 50 per cent more than necessary. The gross metal loss in Heat No. 11 was excessive, and a glance at the log gave the answer as "spilled metal."

LOG USEFUL IN MANY WAYS

The log, then, is useful in answering riddles propounded by eccentric data, but it serves an even more useful purpose in a way which has a direct bearing on the study of reliability and production. Its record should be analyzed and tabulated to show the manner in which time has been spent, usefully or otherwise. Time lost due to failure of the furnace, failure of the auxiliary equipment, lack of skill of the operator and dilatoriness on the part of other foundry employees can each be summed up and given its proper label as avoidable or unavoidable. It is then possible to judge the reliability performance of the furnace fairly and to estimate what production it is capable of giving if the avoidable delays are eliminated, or at least reduced to the point where added supervision brings diminishing returns.

Such a time analysis, made on the operation of an arc furnace in another plant, and covering a period of several days, showed the following conditions:

	Per Cent of Total Time	
Time power on		57.1
Time power off		
Charging, pouring and pulling slag	20.2	
Electrode adjustment and trouble	5.7	
Motor trouble	3.1	
Lunch period	2.2	
Balance of time (wasted)	11.7	
		42.9

By eliminating unnecessary superheating of the metal, arranging the operating schedule so that the furnace was not interrupted during lunch periods, utilizing time which had formerly been altogether wasted and reducing the time spent in electrode adjustment and for remedying troubles of various kinds from 8.8 per cent of the total time to 3.3 per cent, greatly improved results were obtained from this furnace. An average production of 19 to 20 heats per 24 hr. was raised to 24 heats, without changing the furnace in any way, and at the same time the operating cost per ton of metal was greatly reduced. This will illustrate the importance of analyzing the test results in order to credit the furnace with the performance of which it is really capable.

The nature of metal charged, especially its cleanness and state of physical division, must also be considered in determining production. Ingots, chips and borings, thin scrap, heavy scrap, foundry gates and sprues, punchings, concentrate from the recovery plant, etc., will, as a rule, melt down much more rapidly if they are mixed with one another than if an attempt is made to melt any one class by itself. Borings or chips which are oily or wet are particularly troublesome if they are not mixed with cleaner metal in larger pieces. The production of the furnace must be estimated on a basis of the quality of charge which it will actually be called upon to handle. If test results are obtained under conditions which are either uncommonly favorable or peculiarly unfavorable, due allowance must be made for that fact.

Electrical Characteristics

The electrical characteristics, including power input, power factor and steadiness of load, play an important part in determining the output of the furnace, the rate which must be paid for electric energy and the desirability of the load from a central-station viewpoint. If the electrical characteristics of the furnace load are manifestly undesirable in any important respect, the central station may require the furnace user to install auxiliary equipment in order to modify and compensate for the objectionable features. Such equipment is likely to be expensive and must be taken into consideration in determining the installation cost and the investment charges. This applies particularly to large single-phase furnaces in a district supplied by 3-phase power, to furnaces which tend to have a low power factor and to furnaces which are subject to violent fluctuations of power. It is necessary to determine how these factors will influence the cost of power and of the initial installation in the district where the furnace is situated. It may, for example, be necessary to install a motor-generator set, or a phase converter, in order to improve the characteristics of the load; otherwise the power company may be compelled to isolate the furnace load by building a special line to the plant, in which case the manufacturer is likely to be called upon to deposit for a term of years part of the first cost of the new line. On the other hand, if a high-voltage power line, of large capacity and devoted exclusively to power business, happens to be conveniently located, even a single-phase, low power-factor load can be handled by the power company without serious inconvenience.

POWER INPUT

The average power input is measured by taking frequent readings on the wattmeter, or, if a recording wattmeter is used, may be integrated directly from its charts. This result should be checked against the energy input shown by the watt-hour meter. The variations in power input are also of importance; its maximum points and their duration should be noted.

The rate of power input has a direct effect on speed of production, and from that standpoint should be raised to the highest possible point. It is limited, however, by other considerations. For example, in the case of copper alloys, most of the constituents of which are somewhat volatile, too high a power input results in local overheating and excessive metal losses. Steel is not so sensitive, but the best furnace refractories available will not stand up against too rapid generation of heat, at the high temperatures of the steel furnace. In the induction furnace the power input, for a furnace of given size, is limited by still other considerations which need not be discussed here.

RATE OF POWER INPUT IMPORTANT

The rate of power input also has a direct influence in determining the rate paid for electric power. Power, in quantity, is almost universally sold on a schedule which bases the rate on two factors, the maximum demand, and the quantity of energy used. The demand charge consists of a fixed monthly rate per killowatt of demand, and is in addition to the energy charge of a certain sum per kw-hr. used during the month. By maximum demand, in the case of an electric furnace, is meant the highest average power input, during a specified period of time, which has been recorded for the furnace. The period of time taken as a unit of measurement is specified in the rate schedule of the power company, and varies, with different companies, all the way from 5 min. to 3 hr. The methods employed in measuring maximum demand also differ greatly. For example, in one city the maximum demand is taken as the highest average input during any 5-min. period which happens to be selected, and the determination is made with a watt-hour meter and a stopwatch. In another city the maximum demand is taken as the average input during any three indiviuual hours which show the three highest averages, and the determination is made by means of a permanently installed instrument which records the input every 15 minutes.

The maximum demand so determined usually holds good for a considerable period of time (often 12 months) unless it is superseded during that time by a still higher demand, which, in its turn, becomes effective for a similar period. In determining the cost of energy to be used by the furnace it is evidently important to be in a position to predict what maximum demand the furnace will show under the particular rules and regulations which govern the sale of power in the locality where the furnace is to be used. The ideal power curve, from this standpoint, is a straight line, with a maximum average and minimum which are identical, an ideal which, of course, is not satisfied by any electric furnace.

The most desirable power input, under the given conditions, should be approximately determined during the preliminary test, and this value should continue to be used until a more suitable one is established by the intensive and operating tests.

POWER FACTOR

The power factor of resistance or induction furnaces may be measured by means of a power-factor indicator, or may be calculated from the readings of an ammeter, voltmeter and wattmeter. The power factor of an arc furnace may be roughly determined in the same manner, but frequent and violent fluctuations of the power input render it impossible to obtain a very accurate result, unless an average is taken from a large number of readings spread over a considerable period of time. These methods, imperfect as they are in the case of the arc furnace, are, nevertheless, the best means available for learning the variation in power factor during the changing conditions of a single heat, or for comparing separate heats.

When it is desired to determine the average power factor of the furnace during a period of a week or more, the sine-meter method is much to be preferred, and serves equally well with arc, resistance or induction furnaces. In this method two watt-hour meters, differently connected, are used, and, by the use of suitably plotted curves, power factor is calculated from the ratio of the reading of one instrument to that of the other. The method cannot be explained in detail here, but can be found, fully discussed, in standard works on electrical measurements.

In any case, power-factor measurements should be taken in the supply circuit—on the high side of the furnace transformer. The power factor in the furnace circuit is often much higher than that of the supply circuit, and the latter is the significant value.

Since a low power-factor load results in as great a demand on the current-carrying capacity of the power line as does a heavier load at a correspondingly higher power factor, the load with unsatisfactory power factor is sometimes penalized by means of a higher demand charge. This penalty is applied in the case of all power factors below a certain specified minimum, usually in the neighborhood of 60 or 70 per cent.

DETERMINING POWER FACTOR UNDER DIFFERING OPERATING CONDITIONS

It is often desirable to learn what the power factor will be under differing operating conditions. This can best be done during the preliminary test, since, during later tests, uniform operating conditions are to be preferred. The curve in Fig. 1 shows the relationship between arc voltage and power factor in a high-voltage single-phase arc furnace. The power factor of this furnace was low and was subject to a penalty for all values below 70 per cent. It was, therefore, important to maintain the power factor at a point as close as possible to 70 per cent, if higher values proved unattainable. This test, and the curve showing its results, indicated the advantage of operating the furnace at an arc voltage as high as possible with relation to the supply voltage. At higher arc voltages the arc became unstable and could not be held.

The nature of the charge, under the conditions just mentioned, also has an appreciable influence on the stability of the arc, and hence on the power factor. This applies somewhat to the physical nature of the charge, but more particularly to its composition. The presence of any constituent which tends to stabilize the arc makes possible a higher arc voltage and more favorable power factor; the reverse is equally true. Some metals—zinc, for example—have a depressing effect on the arc and, if present in considerable quantity, prevent the maintenance of a high-voltage arc. Certain slagging materials, on the other hand, have a stabilizing influence and improve the power factor. In one case it was found that the concentrates from the foundry recovery plant had a very marked and favorable influence when they formed a considerable percentage of the charge. The various kinds of materials normally making up the furnace charge in the plant, and their effects on the arc, will govern the practice to be followed.

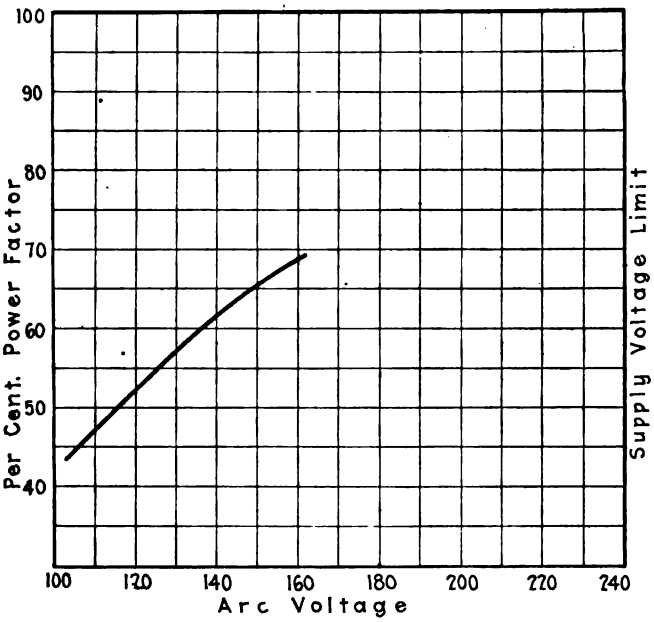


FIG. 1. ARC VOLTAGE AND POWER FACTOR

The relative steadiness of load can be determined, imperfectly by observation, more satisfactorily by the use of a recording wattmeter in the supply circuit. This point is of no great importance to the furnace user, except in its effect upon the attitude of the power supply company. The latter will usually be able to learn from charts taken in its station or substation whether the furnace load is exercising a seriously detrimental influence on its power line. If the power fluctuations are so violent, relative to the capacity of the line, that other customers of the company who take power from the same line are inconvenienced, it is necessary either to transfer the furnace load to a line of higher capacity or to isolate it entirely by building a separate line for its exclusive use. In the case of 2-phase or 3-phase furnaces, unbalancing of the phases may be a serious factor, which, unless it can be overcome by the furnace user, must be remedied by isolation or by the use of compensating equipment.

Resistance and induction furnaces are, as a rule, fairly free from violent fluctuations, and do not tend to unbalance the phases unless they are single-phase furnaces, in which case the unbalancing effect can be definitely predicted.

ADEQUACY OF ELECTRICAL EQUIPMENT

The adequacy of the electrical equipment which supplies the furnace must be learned by observation throughout the series of tests. The furnace transformer and the leads connecting it with the furnace have undoubtedly been chosen to take care of the expected power input at the expected power factor, with an ample margin of safety. If, however, the power input is unexpectedly high, or the power factor not so favorable as had been supposed, the transformer may be dangerously overloaded. The difference in temperature between the transformer oil and the surrounding air, taken when the furnace has been drawing its maximum load for some time, will indicate whether the transformer is likely to overheat seriously at any time, during a hot summer day, for example.

Low power factor may, in some cases, be caused by improperly designed or poorly placed leads, a condition which can be promptly detected and rectified. This subject has been thoroughly discussed by Lindstrom[1] and by Meyer.[2]

Metallurgical Characteristics

The metallurgical characteristics include the loss of metal during the melting operation, the quality of the metal with respect to the uniformity of its composition and the absence of undesirable impurities, the ease with which a specified composition can be produced, and the uniformity of temperature at which the metal is delivered from the furnace. It is upon these features of its performance that the superiority of the electric furnace commonly depends, and they must be determined with great care. With respect to all of these points it is desirable to get an exact comparison between the electric furnace under test and other furnaces operating on the same kind of work under similar conditions.

METAL LOSS

The weight of metal lost during the melting process has a direct bearing upon the cost of operation, whether the metal is irrevocably lost or can be partially recovered from slags, ashes, sweepings, etc. The object of the melting process is to supply useful metal in the ladle or crucible, ready for pouring into castings or ingot. Metal not delivered to the ladle, but which can, nevertheless, be recovered, must obviously be remelted before it becomes useful, and such recovered metal can be credited to the furnace only at its premelted value, after due allowance has been made for the cost of recovery. The gross loss, by which is meant the difference in weight between metal charged and useful metal in the ladle, may sometimes be a more important factor than the net loss, or the discrepancy between metal charged and total metal delivered useful plus recoverable. A furnace showing a gross loss of 3 per cent, with a net loss of 2 per cent, is likely to be more economical than another which operates at a gross loss of 10 per cent and a net loss of only 1 per cent. On the other hand, if the net loss is low, a high gross loss is commonly due to carelessness, and this possibility must be considered in judging the furnace.

---

[1] A. Lindstrom: "Leads for Electric Furnaces," MET & CHEM. ENG., vol. 16, p. 683 (1917).

[2] A. A. Meyer: "Electrical Characteristics of Electric Furnaces," *Trans.*, Am. Electrochem. Soc., vol. 31, p. 269 (1917).

Two general methods are in use for determining metal loss, the choice of which depends upon the nature of metal melted, and also upon the object to be attained. The method of direct weighings must be used when handling a single metal, and is commonly to be preferred in the case of an alloy which contains a considerable percentage of a volatile metal. This includes copper and all of its alloys. Determination of metal loss by chemical analysis applies more particularly to the case of an alloy whose predominant constituent is non-volatile, and which contains small quantities of volatile metals. Many alloy steels fall in this class. The method may also be applied to certain ferro-alloys.

Loss by Direct Weighing

The method of direct weighings may be applied in either of two ways. The most accurate determination of net loss, in the case of copper and its alloys, can be made by pouring the molten metal into ingot molds at the furnace, taking great care to avoid spilling. The furnace is then scraped as clean as possible and these scrapings, together with the slag and spillings, are put through a hand recovery process. The difference between weight of metal charged and weight of ingots is the gross loss for that individual heat. The weight of metal recovered, added to the weight of ingots, is then subtracted from the weight charged, to determine the net loss. Instead of pouring the metal into ingots, the molten metal may be weighed in the ladle. This, however, involves some sacrifice of accuracy and is not to be recommended. Whenever it is worth while to learn the metal loss for individual heats, scrupulous care is justified in making the determination. The metal loss for individual heats becomes of importance when it is desired to learn, within the limits of a short test, the effect of different rates of power input, different pouring temperatures and other variations in operating conditions upon metal loss.

If uniform operating conditions are to be maintained, and it is desired to learn what the average melting loss will be under these conditions, separate determinations for individual heats are not necessary. Under these circumstances it is permissible to weigh the molten metal in ladles, and it is not necessary to scrape the furnace clean or even to pour out the entire melt. The slag and spillings from individual heats need not be kept separate, but should be stored apart from similar accumulations of other furnaces. At the end of a series of heats—preferably ten or more—the furnace should be entirely emptied and cleaned. The accumulated slag and spillings are then weighed and the recoverable metallic content determined. This may be done by hand recovery of a carefully selected sample, or by putting the whole lot through a recovery plant, if such is available. By this method good average results can be obtained, sufficiently accurate to indicate the performance of the furnace in this particular.

In determining metal loss by direct weighings three precautions must be observed. In the first place, the metal charged is often far from clean and, in the case of oily or wet borings, may not be more than 95 per cent metallic. Scrap castings, sprues and gates sometimes introduce a considerable quantity of sand. These non-metallic constituents of the charge may be responsible for a considerable error unless proper allowance is made for them. In case an appreciable weight of metal is added to the melt in the ladle, the addition should be credited as metal melted by the furnace. This correction will reduce the calculated loss somewhat, and plays an even more important part when the consumption of electric energy per ton of metal melted is considered. Metal loss determinations must never be made with a newly lined furnace, since, during the first two or three heats in a fresh lining, metal will seep into the cracks and pores of the refractory; as a result the net metal loss will appear to be about double the normal value.

Loss by Chemical Analysis

The chemical analysis method for determining metal loss is based on the assumption that at least one constituent, which must form a considerable percentage of the charge, is not subject to selective loss; that is, it neither vaporizes nor oxidizes during the melting operation. Any loss of this constituent which may occur is supposed to be due to spilling or spattering, in which case all constituents of the belt are lost in the same relative proportion, and the analysis of the alloy is unchanged. The composition of the charge is known or determined by analysis, and a sample of the metal poured is analyzed. The difference between these analyses is assumed to be due to volatilization or oxidation of constituents other than the one considered stable.

Suppose that we have an alloy which consists of two metals, A and B, and that the analyses, before and after melting, are as follows:

Metal	Before Melting, per Cent.	After Melting, per Cent
A	75.0	76.5
B	25.0	23.5
	100.0	100.0

If we consider that A has suffered no loss—except, possibly, by spilling—we can calculate as follows:

Let relative weight of A before melting = 100.0
Then relative weight of B before melting = 33.3
And relative weight of alloy before melting = 133.3
According to assumption:
Relative weight of A after melting = 100.0
According to analysis:
Relative weight of B after melting = 30.7
Then relative weight of alloy after melting = 130.7
Relative loss of alloy = 133.3 — 130.7 = 2.6
Percentage loss of alloy = 2.6 ÷ 133.3 = 1.95

We conclude, then, that for every 100 lb. of alloy melted we are losing 1.95 lb. of metal, which we assume consists wholly of B, and evaluate our loss accordingly. This, of course, is a net loss, since we cannot very well determine the weight of our spillings by chemical analysis. In respect to determining the gross loss, this method, even at its best, is deficient.

But suppose that there is, after all, a slight loss of metal A, by volatilization or oxidation, much smaller than the loss suffered by B, but still appreciable. Let us say that this loss of A amounts to 0.25 per cent of its original weight. By recalculation we find that, on this basis, our net loss is 2.20 per cent, of which 0.19 per cent is A and 2.01 per cent is B. On a large tonnage basis, this difference between 1.95 per cent and 2.20 per cent would be an important item.

The method of chemical analysis has often been used to calculate zinc losses in the melting of brass and, in doing so, it is always assumed that the relative amount of copper in the alloy remains constant. This is not a correct assumption. There is almost invariably some oxidation of copper, and, in some cases, volatilization as well, with the result that losses calculated in this way are always too low. When we consider the added fact that a slight error in chemical analysis, or a slight lack of uniformity in the alloy as sampled, results in a disproportionately large inaccuracy in the result, it will be seen that this method, by itself, is not suitable for use with copper alloys. It is often valuable, however, if used in conjunction with the method of direct weighings. After the net loss of the alloy as a whole has been learned from the weights taken, the proportionate loss of the constituent metals can be determined by chemical analysis. This is of especial value in case the alloy contains three constituents, two of which are subject to considerable loss. If the three metals differ widely in market value, it is important to learn the proportionate loss of each, in order that the total loss may be correctly evaluated.

In the case of alloy steels, where the alloying constituent is exceedingly valuable, usually added in small quantities, and often subject in marked degree to volatilization and oxidation, determination of loss by direct weighings is of little value. Relatively speaking it is safe to assume that the proportion of iron is stable, and the chemical analysis method can most advantageously be used.

TEMPERATURE OF METAL IMPORTANT

Whatever method is used in determining metal loss, it is of great importance to know the temperature at which metal is delivered from the furnace during the test, particularly in the case of copper alloys. According to Gillett[4], yellow brass (67 per cent copper, 33 per cent zinc) boils at approximately 1120 deg. C. (2048 deg. F.), while the correct pouring temperature for this alloy, if it is to be used in thin castings, is about 1075 deg. C. (1967 deg. F.). This leaves a margin of only 45 deg. C. between the desired pouring temperature and the boiling point of the alloy, at which latter point zinc will be volatilized at a high rate. It is obvious that no reliable comparison can be made between two heats, one of which is poured at, say, 1120 deg. C. (2048 deg. F.) and the other at 1050 deg. C. (1922 deg. F.), unless the difference in temperature is known and its effect discounted. In fact, metal loss figures, not accompanied by a statement of the temperature at which they are taken, lose much of their value and may become a source of serious misunderstanding. Determination of molten metal temperatures, by the best available means, is of the greatest importance, especially during a short test which is expected to furnish data from which estimates of economy can be made.

The quality of metal from the electric furnace should be carefully compared with that obtained from other sources, since superiority in this respect is often the determining factor in the success of electric furnace operation. The basic qualities to be considered are homogeneity of composition and structure, and the absence of undesirable impurities. Upon these depend strength, the percentage of satisfactory castings, and other mechanical and physical properties which have a direct bearing upon the value of the product.

The structure of the metal may be superficially determined by examination of fractures. In some cases this point may be of sufficient importance to warrant a thorough metallographical examination. The presence of impurities and their percentages may be determined by the usual methods of chemical analysis and microscopic examination.

If the strength of the finished casting is of any importance under the conditions to which it is to be subjected in use, suitable tests should be made to determine its strength properties, as compared with castings from metal melted in other furnaces. These tests should, of course, take the form necessary to show what the performance of the casting will be under service conditions, depending upon whether it is to withstand hydraulic pressure, air pressure, steam pressure, tensile or compressive stresses, etc. It is sometimes found that the casting made from electrically melted metal is of appreciably greater strength than castings otherwise produced. This may justify a higher sale price for the casting, or it may make possible the use of a lightweight casting with strength equal to that of heavier castings previously used. In either case the additional profit, or the saving, should be properly accredited to the electric furnace.

DEFECTIVE CASTINGS

Defective castings are a constant source of loss which the foundryman struggles in vain to eliminate, and finally compromises by achieving what he concludes to be an irreducible minimum. This trouble is commonly due to a variety of causes, some of which are not in any way related to the condition of the molten metal as it leaves the furnace. Others, however, can be ascribed to the quality and physical state of the metal, and these can sometimes be almost eliminated by electric melting. So far as practicable, castings from the electric furnace should be separately inspected during the progress of the acceptance test, in order that the percentage of acceptable castings may be compared with similar figures from other furnaces.

In some cases the electrical conductivity of the product is of importance. Tests should be made to determine whether or not the metal from the electric furnace is inherently superior in this respect, and whether the methods commonly used to produce high electrical conductivity can be more easily applied and exactly controlled in the electric than in other furnaces.

In certain instances it has been found that electric steel castings lend themselves unusually well to heat treatment, with the result that the treated castings are of more uniformly high quality than castings from metal melted in other furnaces and subjected to the same heat treatment. Tests should be made to determine the presence of this quality, since it may be a source of saving or of additional profit.

The attainment of a specified metallic composition, within narrow limits, is sometimes an essential in the production of ingot metal or of castings for special purposes. The degree of ease and exactness with which this can be done in the electric furnace, as compared with other furnaces, should be determined in such cases.

---

[4] H. W. Gillett: "Brass-Furnace Practice in the United States," U. S. Bureau of Mines Bull. No. 73, page 129 (1914).

The uniformity of temperature at which metal is delivered from the furnace is important in many ways. When once the correct pouring temperature for an alloy to be used on certain work has been learned, the strictest possible adherence to that temperature will prevent lost heats, save time, result in economy of heat units, minimize metal losses, and make for uniformity in the metal itself. The ease with which the electric furnace under test lends itself to temperature control is a factor to be considered.

In the refining of steel it is sometimes worth while to give separate consideration to the performance of the electric furnace as a melting furnace and as a refining furnace. It may function admirably for one purpose and be almost worthless for the other. Again, its reliability may be high when merely dead melting in an acid lining, while an attempt to carry out a refining process, in a basic lining, may result in a prompt destruction of the refractories. It is unsafe to conclude from a satisfactory performance under one set of conditions that the furnace will be equally successful under a quite different set of conditions. Each point must be considered with reference to the work which the furnace is expected to do, and the cost of removing phosphorus and sulphur, as well as that of carburization, may well be treated as distinct from the cost of melting.

Cost of Operation

The cost of operation is made up of the cost of electric energy used per ton of metal produced, the cost of slagging materials, etc., the cost of labor, the cost of operating auxiliary equipment, such as tilting, electrode-adjusting and water cooling devices, and the expense for carbon, graphite and similar parts which are regularly consumed as a part of the furnace operation.

The cost of electric energy depends upon the thermal efficiency of the furnace and upon those of its electrical characteristics which tend to govern the rate at which electric power is sold. The influence of the power input, the power factor and the steadiness of load have already been discussed. The exact estimation of these factors must be based on local conditions and on the stipulations imposed by the company which is to supply power for the furnace.

ENERGY CONSUMPTION

The quantity of electric energy required by the furnace per ton of metal melted can be stated in various ways, and the published statements concerning this requirement are sometimes very misleading. In one sense the significant value is the number of kilowatt-hours consumed per ton of molten metal delivered in the ladle. This is the economic figure upon which estimates of production cost must be based, but it is contingent, not merely upon the efficiency of the furnace, but also upon the weight of non-metallic material in the charge—which must be evaporated, melted or at least heated to incandescence—and upon the weight of metal volatilized, oxidized, absorbed by the furnace lining, skimmed off with the slag or spilled before it reaches the ladle. From the standpoint of determining the furnace efficiency it is better to base the kilowatt-hour consumption upon the weight of metal charged, thus eliminating the other factors mentioned which have nothing to do with this quality of the furnace. Any statement of energy consumption should be accompanied by information as to the sort of metal charged, whether it is in the form of borings, recovery plant concentrates, light scrap, heavy scrap, ingot or a mixture of these, and whether it carries with it an appreciable quantity of non-metallic material. The state of the metal in these respects plays an important part in determining energy consumption. The approximate temperature at which the metal is poured should also be stated.

In the case of steel any figure given for kilowatt-hour consumption is practically worthless unless all metallurgical conditions are known, whether the process consists of dead melting cold scrap, melting and refining cold scrap or refining a molten charge. In the process of dead melting the energy consumption will be largely influenced by the percentage of iron oxide, or rust, included in the charge. In refining, the percentage of phosphorus and sulphur in the charge, as compared with their percentage in the finished product, plays an important part. The percentage of carbon in the finished steel must also be considered.

During the acceptance test this question of energy consumption must be dealt with from two standpoints. First, what is the inherent thermal efficiency of the furnace, at the required temperature, independent of metallurgical considerations? The final decision as to the heat economy of the furnace, and modifications of design or of operating methods calculated to improve such economy, depend upon an accurate determination of this point. Second, how many kilowatt-hours, per ton of metal produced, will be used by the furnace, in its present form and under the conditions imposed upon it by plant requirements? An adequate answer to this question is required in order that a correct estimate of production cost may be made.

HEAT BALANCE

The inherent thermal efficiency of the furnace is found by making a heat-balance determination. The heat generated in an electric furnace is disposed of in four ways: (1) A portion of the heat is dissipated from the walls and other parts of the furnace by radiation and by convection, (2) another portion is carried away in the water used to cool electrode holders, roof rings, etc., (3) a third portion is lost in the hot gases which escape through the electrode openings, open doors and crevices in the furnace structure, (4) the final and useful portion is absorbed by the metal in raising its temperature to the melting point, melting it and superheating it to the required pouring temperature. If a water-cooling system is not used this source of loss is, of course, eliminated. In determining the heat balance it is usual to make an estimate, based on theoretical considerations, of the heat absorbed by the metal—the pouring temperature of which must be known—measure the heat lost in the cooling water, approximately measure the radiation losses and evaluate other losses by difference. The ratio of heat absorbed by the metal to total heat input is the thermal efficiency of the furnace under the particular conditions existing when measurements are made.

When an electric furnace is started from the cold its walls absorb heat rapidly and radiate it very slowly. As time goes on this heat absorption decreases, radiation losses increase, and the furnace finally reaches an equilibrium at a temperature which depends upon the rate of power input and upon the nature of the metal being melted. Up to this point, the thermal efficiency, starting at a low value, has been increasing, and it reaches its maximum at the equilibrium temperature. The furnace walls may now be said to be saturated, i.e., they contain all of the heat they are capable of holding at the equilibrium temperature. So long as the equilibrium is maintained, the quality of heat held by the walls remains constant, and the rate of radiation loss from the outer walls exactly equals the rate of heat absorption by the inner walls. If the power input is sensibly decreased, the inner walls feed heat back to the metal in the furnace, the equilibrium temperature drops and the radiation losses decrease. During this time the thermal efficiency will apparently be abnormally high, perhaps even higher than 100 per cent, but this apparent value is a false one, since the metal is really receiving part of its heat from heat energy previously stored in the furnace walls. This heat energy must be restored to the walls before the former equilibrium temperature can be regained and a normal rate of melting at a normal efficiency once more attained. If the furnace is allowed to stand inactive the stored heat is lost by radiation from the walls, at a rate which decreases more and more gradually. If the furnace is restarted before the stored heat is altogether gone the remaining portion serves a useful purpose as a foundation upon which to build in restoring the temperature of the furnace to its normal operating value.

DETERMINING LOSS OF HEAT DURING NIGHT

When an electric furnace is operated during the day only, the loss, during the night, of heat energy which has been stored in the furnace walls during the day may become a very serious matter, especially in the case of a heavily-lagged resistance furnace. In testing such a furnace it is worth while to determine, as accurately as possible, what is the absorption capacity of the walls and how much residual heat is still left after the furnace has stood idle for several hours. An exact determination of these values is laborious and inconvenient; an approximate determination, which is at the same time sufficiently accurate, can be made more easily.

For this purpose, a test should be made, starting from the cold, with the furnace empty. The power input should be high enough to heat the furnace about as rapidly as would be the case in actual practice, and the temperature of the furnace chamber should be measured at frequent intervals, by means of a pyrometer. A base metal couple may be used for the lower ranges, but above 1300 deg. C. it is necessary to employ a radiation or optical pyrometer, or some other form of instrument more suited to the higher range. When the furnace has reached its maximum operating temperature the power input should be reduced until it is just sufficient to maintain the temperature at the desired point. This power input—the exact value of which should be determined as closely as possible—is, then, equivalent to the rate of heat loss, expressed in kilowatts, by wall radiation, cooling water, and other sources, at that particular temperature. The power should now be turned off and the furnace allowed to cool, with temperature readings taken at frequent intervals as before.

A cooling curve, drawn from these data, showing furnace temperature plotted against time, may be used to determine rate of heat loss at any given temperature during cooling, and also the quantity of heat still stored in the walls. Such a curve is shown in Fig. 2, illustrating a temperature drop from 1500 deg. C. to 450 deg. C. in 14 hours. In this case the power input required to maintain a temperature of 1500 deg. C. after the furnace had reached an equilibrium at that temperature was 40 kw. At any given moment the rate at which heat is being lost is proportional to the slope of the cooling curve at that point. Knowing this loss to be 40 kw. at the instant power was shut off, the rate of loss at any other point may be determined graphically by the use of the triangles shown, each having a base which represents one hour's cooling, and an altitude which is proportional to the instantaneous rate of cooling at the beginning of the hour.

For example, the rate of cooling at the beginning of the second hour is to the rate of cooling at the beginning of the first hour as *b* is to *a*. We already know that *a* corresponds to 40 kw., and we find by measurement that $b:a::15:24$. Thus we have $b:40::15:24$; $b = 25$ kw., the instantaneous cooling rate at the beginning of the second hour. The lower curve in Fig. 2 shows the rate of cooling throughout the 14-hr. period, determined in this manner for each hour.

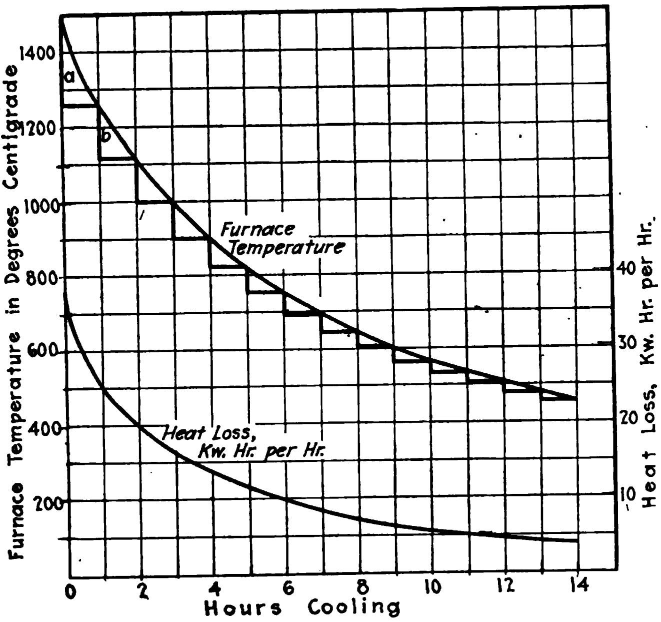


FIG. 2. COOLING RATE OF RESISTANCE FURNACE

It cannot be claimed, of course, that this method gives absolute accuracy, but it does give approximate accuracy in a manner which is at once simple and useful. The cooling curve is exponential and has an equation which is complicated and does not lend itself to rapid calculation. As given, it includes not only the radiation losses, but also the losses by convection of heated air currents, losses in the cooling water—if this is used and continues to flow afer the power has been shut off—and losses by direct conduction where the furnace comes in contact with its supports. In determining the thermal characteristics of a furnace it is of great advantage to group these losses under a single head and thus be able to calculate their net effect. To be strictly correct, one must use as ordinates in such a diagram as shown in Fig. 2, not the actual furnace temperature as measured, but the difference between this temperature and the temperature of the air surrounding the furnace. If cooling water is used, the fact that its temperature is probably lower than room temperature introduces an additional complication, for which correction can be made if desired. In practice these refinements are troublesome and by no means essential, so long as one is dealing with temperatures not lower than 400 or 500 deg. C.

In a furnace which is cooling from a temperature at which it was in a state of equilibrium—that is, saturated with as much heat energy as it would hold at that temperature—it is approximately correct to say that the heat content of the furnace, at any time, expressed in killowatt-hours, is directly proportional to the temperature of the furnace chamber. This is not strictly correct, because the specific heats of the various materials of which the furnace is built are not constant at all temperatures, but experience has shown that the assumption is sufficiently exact for the purpose we have in mind. We can now determine the heat content of the furnace by assuming, first, that the average rate of loss during any hour is the mean of the rates of loss at the beginning and at the end of the hour, and, second, that the total heat loss between any two furnace temperatures is proportional to the difference between those temperatures. On this basis we find that our furnace has lost 32.5 kw.-hr. of stored heat during the first hour, 22.5 kw.-hr. during the second hour, and so on to a total of approximately 158 kw.-hr. during the whole 14-hr. period. During this time the furnace temperature has dropped from 1500 deg. C. to 450 deg. C., or 70 per cent, and therefore, according to our assumption, has lost 70 per cent of its stored heat. The total heat storage at 1500 deg. C was, then, 100 ÷ 70 × 159, or 226 kw.-hr., of which 68 kw.-hr. remained in the furnace at the end of 14 hours.

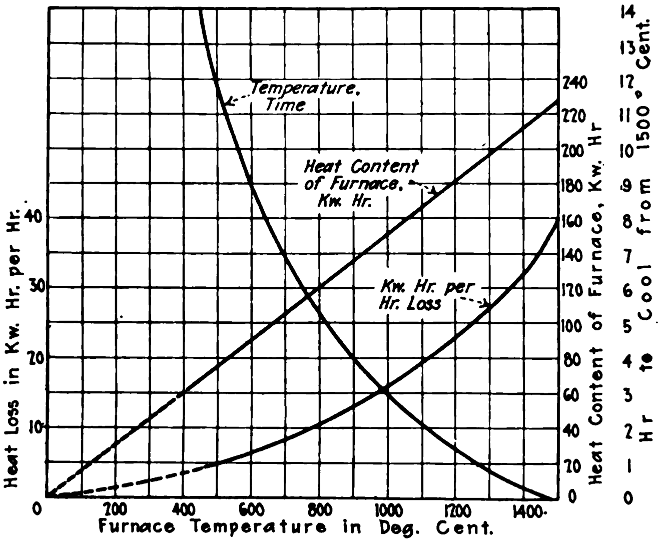


FIG. 3. THERMAL CHARACTERISTICS OF RESISTANCE FURNACE

In Fig. 3 curves are given, based on these data, which show killowatt-hours per hour loss, killowatt-hours heat content of furnace, and hours required to cool to a given temperature, all plotted against furnace temperatures. These curves form a complete diagram of the net thermal characteristics of the furnace, upon which operating schedules may be based, and the correctness of furnace design for the particular work in question may be judged.

Fig. 4 shows an application of this method, in which, under conditions of 10-hr. operation, a test was made to determine the effect of residual heat energy at the beginning of the day, on the time required to complete the first heat, and on the thermal efficiency of the first heat. The higher values of residual energy were obtained by the application of a small power input during the night, the economic value of which in terms of production and operating efficiency could thus be determined without prolonged test.

Fig. 5 shows a diagram of one day's operation, in which the percentage of total energy input, as utilized and dissipated in various ways, is plotted against the total input expressed in killowatt-hours. *A* represents the heat absorbed by the metal, calculated as 160 kw.-hr. per ton of brass at 1090 deg. C. (1994 deg. F.), *B* the various heat losses from the furnace during operation, and *C* the heat absorbed by the furnace structure as its temperature rises. In each of the rectangles shown in the diagram, the altitude indicates the percentage of heat input disposed of in the manner indicated, while its area is proportional to the heat input in kilowatt-hours. In rectangles marked *A* the altitude represents also the thermal efficiency of the furnace during each heat. The shaded areas indicate the heat energy stored in the walls of the furnace, that marked "Residual" being the initial stored heat with which the furnace started the day. The figures show the numerical values of each area in kilowatt-hours. The broken-line curve indicates the rate at which heat is being stored by the furnace, or —what is virtually the same thing—the rate of temperature rise.

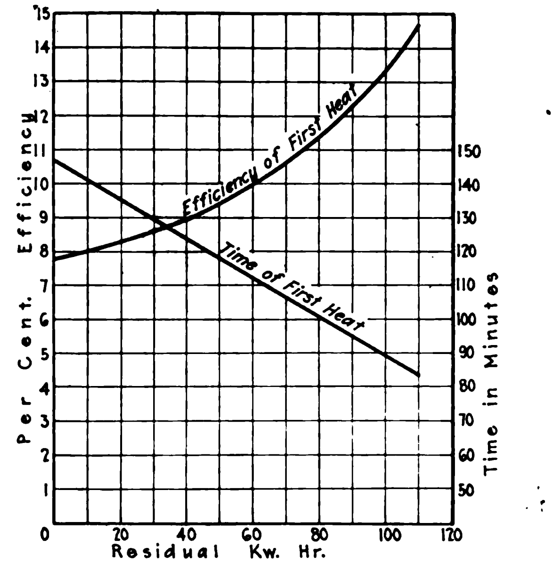


FIG. 4. RESIDUAL ENERGY-EFFICIENCY AND TIME, FIRST HEAT OF DAY

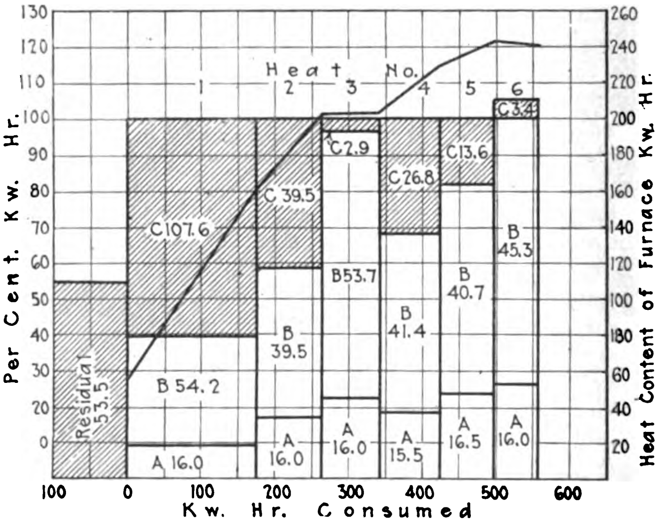


FIG. 5. HEAT BALANCE OF RESISTANCE FURNACE

It will be noted, in this diagram, that during the first two heats a relatively enormous amount of energy was being stored by the furnace and its temperature increased rapidly. The third heat covered part of the lunch period, during which power was turned off. As a result the furnace temperature increased very little and the apparent efficiency was comparatively high. The efficiency dropped during the fourth heat as the rate of heat absorption by the furnace again increased. The maximum operating temperature of the furnace was not reached until the end of the fifth heat. During the sixth heat the furnace "coasted," that is, the power input was reduced to such an extent that the furnace temperature began to decline slowly, and the furnace walls gave up part of their stored energy to heat the metal and supply radiation losses, which is shown graphically by the fact that the rectangle *C* is above the 100 per cent line and really has a negative value. At the same time this coasting caused the apparent thermal efficiency to rise to a value somewhat higher than the true efficiency.

In the study of heavily lagged resistance furnaces, such curves and diagrams as these, based on data covering only a few days' operation, are of more value than weeks of operation unsupplemented by graphical interpretation. By the use of these methods the performance of the furnace under different conditions, as well as its merits and defects of design, can be evaluated with surprising accuracy, and desirable changes in design and operating methods can be made with a considerable degree of precision.

COOLING-WATER LOSS

In making a heat balance it is sometimes desirable to know what portion of the energy input is being carried away in the cooling water. This is determined by measuring the temperature of the incoming and of the outgoing water, and weighing the water used during a certain time period, or measuring the water by means of a water meter. Multiplying the weight of the water in pounds by its temperature rise in degrees F. gives its acquired heat content in B.t.u., and this may be converted into killowatt-hours by dividing by 3416. The rate of heat loss in killowatts may then be determined by dividing the heat gain in kilowatt-hours by the fraction of an hour during which the observed weight of water was used.

Several such determinations are necessary in order to get a good average value, and it is sometimes advisable to determine the rate of loss at different speeds of cooling-water flow, and to observe the general effect of this variation on furnace operation, in order that the use of cooling water may be so adjusted as to obtain the highest overall economy. The magnitude of this loss is frequently in the neighborhood of 10 per cent of the total power input, and, under favorable conditions, may be much higher.

While the heat-balance determination indicates the fundamental thermal characteristics of the furnace *per se,* the only way to learn what the energy consumption will be under practical conditions in any specified plant is by careful observation of the kilowatt-hours used from heat to heat. Since different heats are often subject to different conditions, it is important to note the energy consumption on each heat and to accompany these data with an adequate description of the conditions—such a description as given by the furnace log—in order that the effect of varying conditions may be learned. For this purpose, as already stated, it is necessary to use a watt-hour meter, the readings of which may be estimated with fair accuracy to 1 kw.-hr. as a unit, unless the furnace is large, using, say, as much as 1000 kw.-hr. per heat—in which case readings taken in tens of kilowatt-hours are close enough.

During the preliminary test one should learn approximately what energy consumption is to be expected. The brief intensive test should furnish data to show the best results of which the furnace is capable, when operating under regular plant conditions but subject to very careful supervision. These figures may be used as a basic value with which to compare results obtained during the more extensive operating test, with supervision reduced to a practical minimum. The information thus obtained, together with the heat balance, is sufficiently comprehensive to justify complete estimates covering the effect of all conditions likely to be encountered, the relative economy of various operating schedules which may be proposed, the advisability of changes in design, and the influence of human factors such as skill of the operator, attitude of foremen and laborers in the plant, etc.

The energy consumption per ton of metal depends in marked degree upon the temperature to which the metal is heated by the furnace. Useful comparisons are impossible unless the approximate temperature of the metal is known. The importance of the pyrometer in electric-furnace testing has already been emphasized, and, in connection with determinations of energy consumption, can hardly be overemphasized.

MATERIALS AND LABOR

The cost of raw materials includes fluxes and slagging materials, and the cost of the metal charged. Fluxes, etc., constitute a relatively small item, but one which, nevertheless, should be recognized and included in the balance sheet. The cost of metal charged is a production rather than an operating cost, but, under certain conditions, should be included under operating costs as a differential when comparisons are to be made with other types of furnaces. For example, if it is found that the electric furnace requires a less expensive grade of metal than is used by some other furnace, in order to turn out the same quality of product, the difference in cost should be credited to electric-furnace operation. Or if, as sometimes happens, the electric furnace can utilize as part of its charge badly oxidized or otherwise impure material which would otherwise have to be sold at a loss, this saving should be credited in a similar manner. Of course, if the reverse is true, the differential consists of a charge against the electric furnace instead of a credit.

Throughout the acceptance test the labor required to operate the electric furnace should be carefully observed, in order that the labor necessary, not merely as to quantity but also with respect to quality, may be accurately estimated when the test has been completed. The comparison between the intensive test and the operating test, the latter with reduced supervision, will indicate how expensive a grade of labor is justified on economic grounds.

Auxiliary equipment, such as tilting motors and electrode-regulating apparatus, must ordinarily receive their power supply from a separate circuit, since the characteristics of the furnace circuit are usually unfavorable to their operation. Their use of electric energy may be estimated, if desired, but is so small as compared with that used by the furnace that the cost of energy consumed in this way is not an important factor. The cost of water used in cooling electrode holders or other parts of the furnace equipment may under some conditions deserve a place in the table of costs, although it is, of course, small.

The cost of carbon, graphite or other materials of a similar nature, which are employed in electrodes or resistor parts, is an operating cost, provided these materials are regularly consumed during operation. Such materials as are relatively long-lived, and replaced at irregular intervals, are more properly considered under the head of maintenance cost.

Carbon and graphite parts are usually purchased by the pound, and the weight consumed per ton of metal produced should be determined. In the case of electrodes for arc furnaces, where breakage is an important factor, it is worth while to differentiate between electrode consumption and electrode breakage. This can be done by weighing the broken pieces of electrode, from time to time, as they accumulate, and comparing this weight with the total weight of electrodes used during the same period. Electrode breakage is, theoretically, an avoidable waste and a good deal of time and effort can profitably be spent in reducing it to a minimum. Any pronounced discrepancy between electrode consumption, as determined during the intensive test, and that found in practice during the operating test should be thoroughly investigated.

Maintenance Cost

The cost of maintenance includes the expense involved in renewing the refractory parts of the furnace from time to time, and in making such repairs as may be necessary on the furnace and its auxiliary equipment. The necessary observations include the nature and weight of materials used and the quantity and quality of labor required, all to be reduced to a basis of cost per ton of metal output. If the renewals and repairs involve serious interruptions of operation, special consideration must be given them under the head of reliability and production.

The cost of refractories is difficult to determine in a test of short duration. If the furnace is well designed, and well suited to its purpose, its refractory parts will not need very many or very extensive renewals during the course of a two-months test, and it is not easy to estimate from the results of such a test what the cost of refractories will be over a period of, say, one year. The best estimate which can be made must be based on close observation of the condition of the roof and lining at frequent intervals. In the case of an arc furnace the roof may have to be replaced one or more times, particularly if the furnace is operated continuously, and the cost of renewal should be carefully noted. In an induction furnace the lining will be subject to much more rapid wear than the roof, and the effect of alternate heating and cooling, if the furnace is not run continuously, should be carefully noted.

CONSIDERATION FOR SAVING IN MATERIALS

In making cost estimates with respect to refractories, due consideration should be given to the possibility of using less expensive or more durable materials, which may happen to be well suited to the work in question. For example, it has been found that in melting certain classes of copper alloys in an arc furnace, roofs constructed of ordinary firebrick are not only cheaper in first cost than those of silica brick, but are also more durable.

Miscellaneous Considerations

There are a variety of miscellaneous factors, not so far considered, which play either a direct or an indirect part in determining the cost of production or the overhead expense of the plant. Taxes and interest charges on the investment, the loss involved in disposing of equipment already in use, depreciation and obsolescence charges against the electric furnace equipment, make up one group which affects production cost directly. If the electric furnace makes possible a saving in floor space which is really needed for other purposes, or if it reduces the insurance rate for the plant, these are also items which can be evaluated with a fair degree of exactness.

Depreciation and obsolescence charges lend themselves excellently well to what may be termed scientific juggling resulting in almost any conclusion which the juggler may wish to reach. A few general principles should be observed in making such estimates. In the first place, the transformers, foundations, furnace leads, instruments, etc., should always be included with the furnace. As a rule these items are specially designed for use with the particular furnace in question, and are of much less value for any other purpose. Their depreciation should be calculated at the same rate as that of the furnace.

No well established rule will be found for calculating electric-furnace depreciation. The proper rate to use will vary with circumstances. The writer has in mind one installation, just going in, where a depreciation rate of not more than 5 per cent per annum might well be used. In applications where a well standardized furnace has long been used in other plants for the same purpose, 10 per cent is a conservative value. This applies particularly to certain well known furnaces widely used for melting and refining steel. In other cases, where the application is a relatively new one and the electric furnaces now in use are pioneers, obsolescence becomes the governing factor and 20 per cent is a safer value. There are some installations, established solely as a result of the abnormal conditions existing during the war, which lost about 90 per cent of their value on the day the armistice was signed.

The advantages of greater cleanliness and less noise, which often favor the electric furnace, as well as that of greatly reduced radiation of heat, which always accompanies electric-furnace operation, are of such a nature that they cannot be exactly evaluated. The net effect of such indirect advantages is very different in different locations, depends largely upon the type of fuel-fired furnace with which the electric furnace is being compared, and, in its influence on working conditions and other considerations, both economic and æsthetic, its importance will depend upon the climate, the class of labor employed, the location of the plant with respect to residence sections and other buildings, public or private, and finally, on the attitude of the plant management in dealing with considerations which have to do principally with the welfare of employees and questions of public interest. The question of poisonous and unpleasant fumes and gases given off during the melting operation has a similar bearing on the subject. In this connection the degree of ventilation which already exists in the plant, or may easily be attained, must also be considered.

Up to this point we have considered separately the individual features of electric-furnace performance, the bearing which each has upon the performance as a whole, and methods for obtaining adequate and reliable data with respect to these factors during the progress of an acceptance test, made in an industrial plant under commercial conditions. When the test has been completed and the desired information is all in hand, there still remains the task of summarizing the results, scrutinizing each detail in the light of its influence on the final result and giving to each its proper weight, totaling the costs and estimating what these will be under such variety of conditions as are likely to be met with in the plant concerned, comparing these costs with corresponding figures obtained from other sources, and, finally, giving judgment as to the overall value of the furnace for use in the plant in which it has been tested. The correctness of the conclusions reached will depend no less on the use of good sense and engineering judgment in interpreting results than on the skill and care with which the test has been made.

Questions to Be Answered

The engineer charged with the task of judging the quality of performance which the furnace has shown must, after a careful study of the data, arrive at the correct answers for the questions given below, preferably to be considered in the order given. Not all of these questions need be considered in every case. Which of them are pertinent depends upon the nature of the furnace tested and upon the requirements of the plant in which its use is proposed.

A. SUITABILITY

Is the furnace suitable, in a general way, for the work which it is expected to do? Will it produce a marketable product from suitable raw materials without any gross failure to meet the requirements of the industry in other respects? If it is lacking in this regard, is its failure due to some fault inherent in its design, or can its performance be rectified by minor changes in construction or operating methods?

B. RELIABILITY

Is the furnace sufficiently reliable in its operation to be classed as an industrial tool? If its apparent reliability leaves something to be desired, what part of the trouble should be ascribed to the furnace itself and what to imperfections in its auxiliary equipment or other contributing causes? Can the difficulty be overcome in any practical way?

C. PRODUCTION

What rate of production can the furnace be expected to show under the conditions normally existing in the plant? Can this rate be increased, under existing conditions, by changes in furnace design or operating methods? What rate of production is the furnace capable of, if conditions are modified to meet its requirements? Does the increased production thus made possible seem to justify the necessary modifications?

D. NATURE OF METAL HANDLED

Is the furnace capable of handling in a satisfactory manner all of the various forms of metal which it is desired to use in this plant? Is it more or less satisfactory than other furnaces in this respect?

E. ELECTRICAL CHARACTERISTICS

1. *Power Input.* What is the average power input of the furnace under the various conditions of its use? Is it, for any reason, desirable to raise or lower this input, and, if so, how readily can this be done?

2. *Power Factor.* What is the average power factor of the furnace? Is it so low as to subject the furnace load to a penalty which will affect the rate paid for electric energy? If there is danger of this, how can the power factor be maintained at the highest practicable value?

3. *Steadiness of Load.* Is the power input subject to violent fluctuations which may be dangerous to the transformers or objectionable to the power company? If so, how can this condition best be remedied?

4. *Adequacy of Electrical Equipment.* Are the transformers, leads and other electrical equipment suitably designed and connected for use with the furnace? If not, what changes should be made?

5. *Rates for Electric Power.* With the electrical characteristics of the furnace as they are, and at the estimated use of power, what will be the average cost per unit of electric energy used? Can this cost be reduced?

Are the electrical characteristics of the furnace such that it constitutes an undesirable load for the local power company or for the power system of the plant? How readily, if at all, can undesirable characteristics be improved? Are conditions such that it will be necessary to install additional equipment in order to compensate for undesirable characteristics? If so, how can this best be done and what will it cost to install and operate such equipment?

F. METALLURGICAL CHARACTERISTICS

1. *Metal Loss.* What gross and net metal losses are experienced with the furnace under the conditions of its use? How does it compare with other furnaces in this respect? Can the results obtained during the test be improved upon? What is the value of the loss expressed in cost per ton of metal produced?

2. *Quality of Metal.* How does the quality of metal produced by the furnace compare with that from other furnaces, judging it according to the purposes for which the finished product is to be used? Is it likely that better results can be obtained? Does the furnace make possible a product which can be sold at a price above the average? Does it make direct savings in production as compared with other furnaces?

How do the metallurgical characteristics of the furnace compare with those of other furnaces used on similar work? Can the furnace be improved in this respect?

G. COST OF OPERATION AND MAINTENANCE

1. *Energy Consumption.* What energy consumption does the furnace show, per ton of metal produced, under the conditions of its use? In this respect, how does the furnace compare with other electric furnaces doing similar work? Is the furnace capable of giving better results?

2. *Thermal Efficiency.* What is the inherent thermal efficiency of the furnace? How well do its thermal characteristics conform to requirements imposed by the operating schedule of the plant? Can these characteristics be changed for the better? Would it be advantageous to modify the operating schedule?

3. *Cost of Carbon and Graphite Parts.* What is the cost, per ton of metal produced, for electrodes or other carbon and graphite parts? How much of this cost is necessary and how much due to avoidable waste? What seems to be the minimum practicable cost of this item? How does the furnace compare with other electric furnaces in this respect?

4. *Labor.* What is the labor cost per ton of metal produced? Can this item be reduced? Would it decrease if the installation were to be enlarged by the addition of more furnaces? How does this cost compare with that for other furnaces, electric or fuel-fired? What grade of labor should be employed to produce most economical results?

5. *Metal Charged.* Does the furnace show greater or less economy than other furnaces with respect to the grade of raw materials which it utilizes?

6. *Miscellaneous Materials.* What is the total cost, per ton of metal produced, for incidentals such as fluxes, slagging materials, water, etc.?

7. *Refractories.* What is the cost, per ton of metal produced, for renewing furnace refractories? How does the furnace compare in this respect with other electric furnaces? Can the overall economy be improved by substituting cheaper or more durable refractories for some of those now in use?

How does the overall cost of operation compare with that of other furnaces under similar conditions? Is it probable that this cost can be reduced?

H. OTHER CONSIDERATIONS

1. *Depreciation.* What rate should be charged for depreciation or obsolescence of the electric furnace installation? What does this amount to in cost per ton of metal produced, on a basis of the estimated production?

2. *Interest and Taxes.* What is the estimated cost, per ton of metal produced, for interest and taxes on the electric furnace investment?

3. *Miscellaneous Economic Considerations.* Does the furnace make possible a saving in plant insurance rates

as compared with other furnaces in use or under consideration? Does the furnace make possible a saving in floor space which is really needed for other purposes?

4. *Working Conditions.* Does the furnace possess advantages over other types of furnaces with respect to cleanliness, silence of operation, absence of excessive radiated heat, freedom from noxious gases and fumes, and the like, which have a bearing on the health and efficiency of the workmen, and, in general, on the hygienic condition of the plant and its surroundings? Of what importance are these advantages under the conditions which exist in and around the particular plant in question?

Summarizing these factors, does the furnace possess peculiar advantages, as compared with other furnaces, by virtue of its ability to utilize cheaper raw materials, or its ability to save materials otherwise unavoidably lost, or its ability to turn out a product of higher grade?

Exclusive of such of these advantages as it may possess, does the furnace show a higher or a lower operating cost than other furnaces?

Considering both special savings and operating costs, how does the overall economy of the furnace compare with that of other furnaces under consideration?

Does the furnace possess incidental qualities, not easily evaluated in dollars and cents, which have any bearing for or against its use?

Considering the overall economy of the furnace, together with such special and incidental advantages as it may possess or lack, does it seem advisable to choose this particular furnace as new equipment in preference to other furnaces which might be used?

What loss would be involved in selling, or consigning to the scrap pile, other furnaces already in use in the plant, and replacing them with additional electric furnaces of the type under test? Is this action advisable?

If the present superiority of the electric furnace for use in this plant is based on abnormal conditions, what will be its status when these conditions no longer exist?

If the adoption of the electric furnace is not now advisable, is it likely to become so under changed circumstances which may be expected to arise in the future?

In answering these questions the engineer who is reporting the test will have covered very thoroughly all of the technical and economic factors which play a part in the success or failure of electric furnace installations in the field under discussion. The matter of general supervision and plant overhead is not included, as this question depends upon many factors which have little or nothing to do with the electric furnace, factors concerning which the engineer who is testing the furnace can hardly be expected to have complete information. In any case this item will be much the same for one furnace installation as for another, provided the rate of plant production is identical. The plant manager, if he has before him such a report as that indicated above, can reach a final decision concerning the furnace, which will be based on all the facts, accurately determined and adequately presented.

Detroit Electric Furnace Co.,
Detroit, Mich.

Industrial Analysis of Gas Mixtures by the Refractometric Method

THE June, 1919, issue of *Chimie et Industrie* contains a comprehensive description of the application of interference phenomena to the industrial analysis of gas mixtures, by Prof. Marcel Pouchon.[1] The following is an abstract of this interesting study.

The volumetric and gravimetric methods of gas analysis present disadvantages which are not encountered when using the method based on the variation of the index of refraction of gases. To obtain the index of refraction of a gas mixture it is necessary to know the index of each of the components. The refractometric method is applied easily when analyzing a binary mixture. For more complex mixtures this method does not offer any appreciable advantage over the standard volumetric and gravimetric methods.

The main difficulty encountered in the application of this method is the smallness of the value to be measured. Thus, the difference of the index of refraction between pure air and a mixture air-carbon dioxide (say 95 per cent air, 5 per cent carbon dioxide) is about 10^{-5}. To obtain results accurate to within ±.1 per cent, the readings have to be taken with an exactitude of 10^{-7}. This extreme sensibility is secured by the application of the phenomena of interference as obtained when using Lord Rayleigh's gas interferometer.[2]

LORD RAYLEIGH'S PORTABLE INTERFEROMETER

There are two types of gas interferometers, the laboratory type and the portable type. The portable type (Fig. 1), which is used industrially, is represented schematically in plan and elevation in Figs. 2 and 3[3]. It consists of (1) a vertical slit F_1F_2, source of light s, lens l, mirror m and prism p; (2) a lens L the focal plane of which contains the slit F_1F_2; (3) two glass plates C,C' of which the plate C' is movable around the horizontal axis aa; (4) a glass parallelopiped P; (5) a plane mirror M; (6) two gas chambers G,G' closed at their parallel extremities with glass plates.

PRINCIPLE OF THE APPARATUS

At F_1, the upper part of the slit, there are formed two pencils P_1 and P_1' which pass through the plates C,C', the gas chambers G,G', then are reflected by M back through the gas chambers G,G', and plates C,C', and form after passing through the lens L interference bands in F_1'.

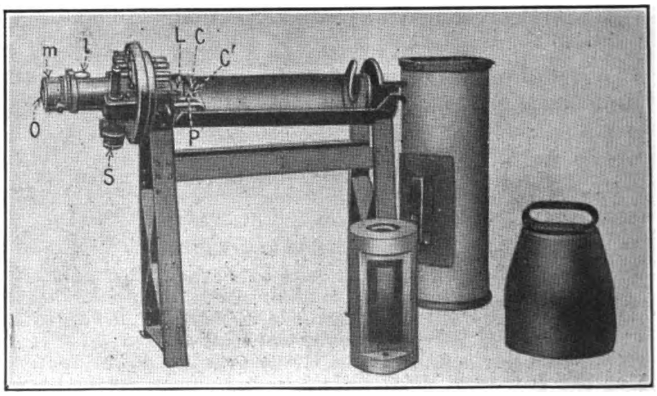


FIG. 1.

At F_2, the lower part of the slit, there are formed two pencils P_2 and P_2' which pass through the lens L and are then deflected by P so as to sidestep the gas chambers G,G' and reflected by the mirror M back through P and L, when the pencils form bands in F_2'.

These two systems of bands are spaced one over the other and separated by a horizontal black band. The observations are made through a cylindical lens O. The central band only is achromatic, the others are colored and can be easily distinguished.

---

[1] Prof. Marcel Pouchon, "Analyse industrielle des Mélanges Gazeux par la Méthode Réfractometrique." *Chimie et Industrie*, June, 1919, pp. 647-655.

[2] Lord Rayleigh, *Proc. Roy. Soc.* (A), vol. 59, 1896, and vol. 64, 1898. F. Lowe, *Physik. Z.*, vol. 11, 1910.

[3] The laboratory type of Lord Rayleigh's gas interferometer is described by Frank M. Seibert and Walter C. Harpster in the U. S. Bureau of Mines Technical Paper No. 185, 1918.

By turning the plate C' around the axis aa the path of the pencils P' and P_1' can be varied and by this means displace laterally the upper system of bands. The two central bands can thus be aligned. Under these conditions the optical paths followed by the pencils P_1 and P_1' are the same. The displacement given to C' is measured by the micrometer screw S (see Fig. 1).

METHOD OF OPERATION

To measure the difference of the index of refraction of two gases it is first necessary to start with filling the two gas chambers G and G' with a standard gas, and by manipulating the micrometer screw S, C' is brought to the position where the two central bands are in alignment, and the position of the micrometer is noted. This is the zero point. Now one of the gas chambers, say G', is filled with the gas to be studied and the central bands are again aligned by means of S. The new position of C' is noted, and the displacement of the micrometer screw S measures the variation of the optical path of P' when the standard gas is replaced by the gas to be studied. This displacement is a function of the difference of the index of refraction of the two gases.

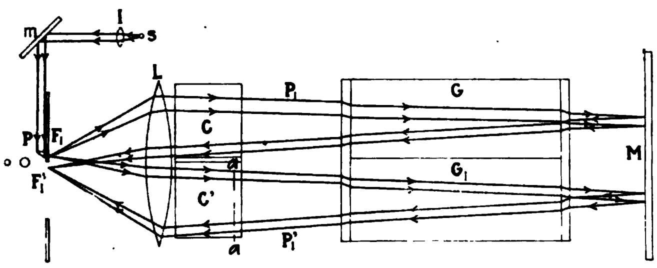


FIG. 2

Every apparatus has to be standardized, by using as standard gas and as a gas to be studied gases whose indices of refraction are well known, such as carbon dioxide, ammonia, etc.

The displacements of the micrometric screws are proportional to the variation of the index, i.e., the readings plotted with the micrometer displacements as abscissæ and the difference of indices of refraction as ordinates give a straight line (see Fig. 4). This is the standardizing curve. The sensitiveness of the apparatus depends on the length of the gas chambers G, G': The longer the chambers, the more sensitive the apparatus.

Although the apparatus once standardized can be considered as such indefinitely, it is better to restandardize it from time to time and check the standardizing curve.

ANALYSIS OF A GAS MIXTURE

A gas mixture is analyzed by comparing it to one of its constituents taken as standard gas, and the results are calculated by the application of the following laws:

(*a*) *The refractivity of a gas is proportional to its absolute density.*

$$\frac{N-1}{D} = \text{constant} \qquad (1)$$

in which N is the absolute index of refraction of the gas and D the absolute density or mass per unit volume of the gas under given conditions of temperature and pressure.

(*b*) *The refractivity of a gas mixture is equal to the sum of the refractivities of each of the gases at the pressure they would have if they were to occupy individually the total volume.*

$$N - 1 = (N_1 - 1) + (N_2 - 1) + \dots \qquad (2)$$

in which N is the absolute index of the mixture and N_1, N_2, ... the indices of the components at the pressure they would have if they were to occupy individually the total volume.

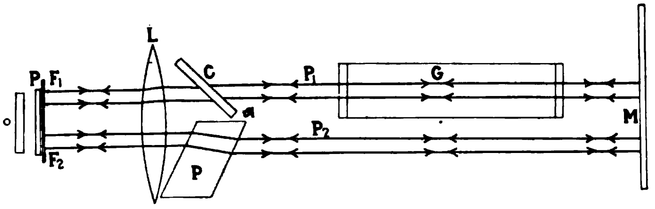


FIG. 3

From these two formulæ it is found that for a binary mixture if N_1' is the index of refraction of a pure compound initially filling the gas chamber G', N'' the index of the mixture to be analyzed, p_2 the mass of one of the components contained in a unit volume of the gaseous mixture and d_2 its relative density (the other component being taken as the standard)

$$p_2 = d_2 a \frac{N'' - N_1'}{N_2 - N_1} \qquad (3)$$

when the gases filling the gas chambers G and G' are at the same temperature and pressure.

The weight of the constituent not taken as standard, contained in the unit volume of the mixture at the experimental temperature and pressure, is proportional to the difference between the index of refraction of the

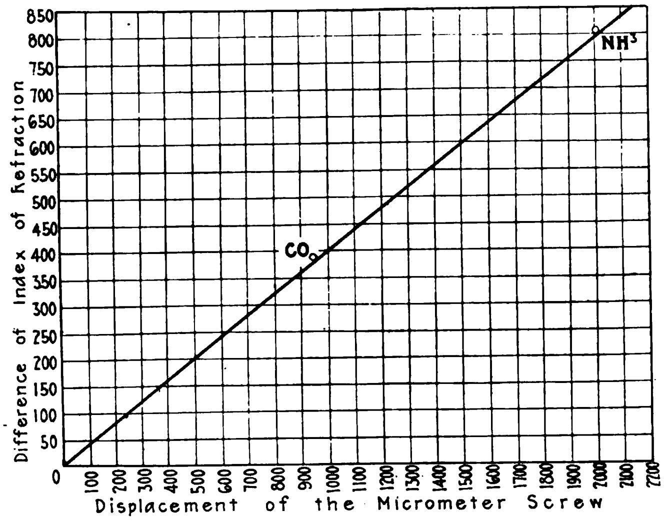


FIG. 4

TABLE I—VERIFICATION OF THE PROPORTIONALITY OF THE DISPLACEMENT OF THE MICROMETER SCREW TO THE WEIGHTS OF ONE OF THE CONSTITUENTS IN THE UNIT VOLUME OF THE MIXTURE

Gas Mixed with Air (1)	Composition of the Mixture to Be Studied (2)	Displacement of the Micrometer Screw (3)	Value (2) / Value (3) (4)
	Grams per cu.m.	Divisions	
Carbon dioxide	49.0	96	0.510
	313.0	613	0.510
	585.0	1140	0.513
	1230.0	2410	0.510
Ethyl alcohol	67.5	436	0.154
	87.0	565	0.154
	100.0	635	0.157
	114.0	734	0.155

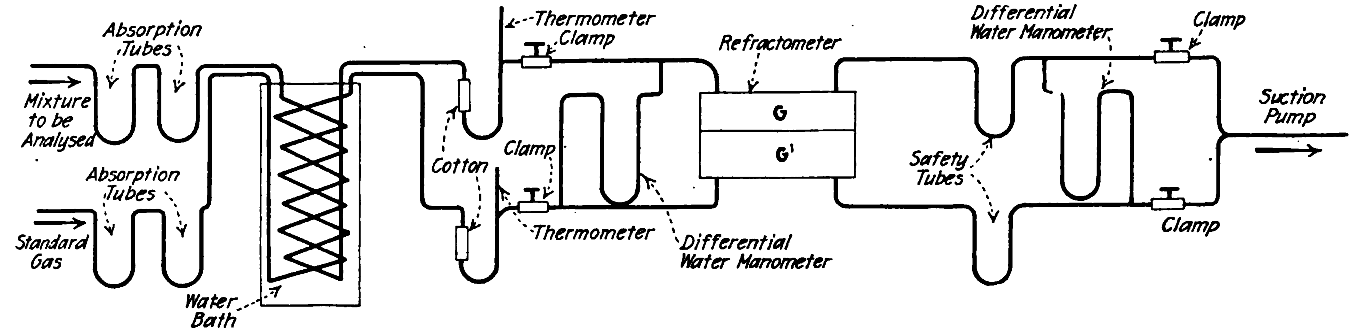

Absorption Tubes
Mixture to be Analysed
Absorption Tubes
Standard Gas
Water Bath
Thermometer
Clamp
Cotton
Clamp
Thermometer
Refractometer
G
G'
Differential Water Manometer
Differential Water Manometer
Safety Tubes
Clamp
Clamp
Suction Pump

FIG. 5

mixture and that of the constituent taken as standard, i.e., to the displacement of the micrometer screw.

This proportionality is easily verified experimentally. Thus, taking pure air as the standard gas and as the gas to be studied, the mixtures air-carbon dioxide, air-alcohol, etc., the results shown in Table I were obtained.

PRECISION OF THE RESULTS

In the value $p_2 = d_2 a \frac{N'' - N_1'}{N_2 - N_1}$ errors can be made on the factors $N'' - N_1'$, $N_2 - N_1$, d_2 and a. The errors on d_2 and a are practically negligible. Experiments have shown that the error made when bringing the two central bands into alignment is not more than 1 × 10^{-7} in the index difference. The error in p_2 varies with the difference $N'' - N_1'$; $N_2 - N_1$ is known within a limited precision.

Table II gives examples of the precision reached with different gases mixed with air, assuming $N'' - N_1'$ known to ± 1 × 10^{-7}. Table III gives the indices of refraction of some gases.

TABLE II—PRECISION OF THE RESULTS OBTAINED IN THE ANALYSIS OF MIXTURES OF AIR WITH SOME GASES

Gas Mixed with Air	Error on p_2, Grams per cu.m.	Gas Mixed with Air	Error on p_2, Grams per cu.m.
Nitrogen	24	Acetone	0.3
Oxygen	5	Ordin. ether	0.3
Carbon monoxide	3	Ethyl alcohol	0.3
Water	2	Methane	0.5
Carbon dioxide	1		

TABLE III—INDICES OF REFRACTION OF SOME GASES

Gas	Index of Refraction	Gas	Index of Refraction
Air	1.0002926	Sulphur dioxide	1.000660
Nitrogen	1.0002978	Acetone	1.001079
Hydrogen	1.0001390	Benzene	1.001691
Oxygen	1.000272	Ordin. ether	1.001535
Ammonia	1.000377	Ethyl alcohol	1.000881
Carbon monoxide	1.0003342	Methane	1.0004438
Carbon dioxide	1.0004502	Ethane	1.0007528
Water	1.000257	Pentane	1.001701
Chlorine	1.000769		

The absolute error in N_1 and N_2 is of the 10^{-6} order, but the difference $N_2 - N_1$ varies in appreciable proportion. Thus it is 52 × 10^{-7} for nitrogen and air, 1576 × 10^{-7} for carbon dioxide and air, 12420 × 10^{-7} for ether and air, etc. It follows that:

In the analysis of a mixture in which the amount of one of the constituents is small, the precision of the results depends solely on the precision of the micrometer screw readings.

In the analysis of a mixture in which both constituents are in about the same proportion, the precision of the results depends equally on the precisions of the readings and of that of their individual indices of refraction.

In this last case it is advisable not to use the formula $p_2 = d_2 a \frac{N'' - N_1'}{N_2 - N_1}$, but to standardize the apparatus by comparison with chemical analyses.

Differences of pressure up to ± 5 mm. of water and of temperature up to ± 0.1 deg. C. of the gases in the chambers *G*, *G'* can be considered as having practically no influence on the error in the final result.

ARRANGEMENTS FOR INDUSTRIAL GAS ANALYSES

Figs. 5 and 6 show convenient arrangements for the industrial analyses of gases by Lord Rayleigh's interferometer. The water bath brings the gases to the same temperature. The equality of pressure of the gases is obtained in the first arrangement (Fig. 5) by adjusting the clamps and in the second case (Fig. 6) by putting the gas chambers *G* and *G'* in communication with the atmosphere through the 3-way stopcocks.

The first arrangement is preferable when frequent readings are required, say every 5 seconds. The second arrangement gives more accurate results, and is simpler and easier to handle, but the readings can be taken only every 15 to 20 seconds.

ANALYSIS OF TERNARY GAS MIXTURES

If p_1, p_2, p_3 are the weights of the constituents contained in the unit volumes of the mixture; d_1, d_2, d_3 their relative densities, N_1, N_2, N_3 their refraction in-

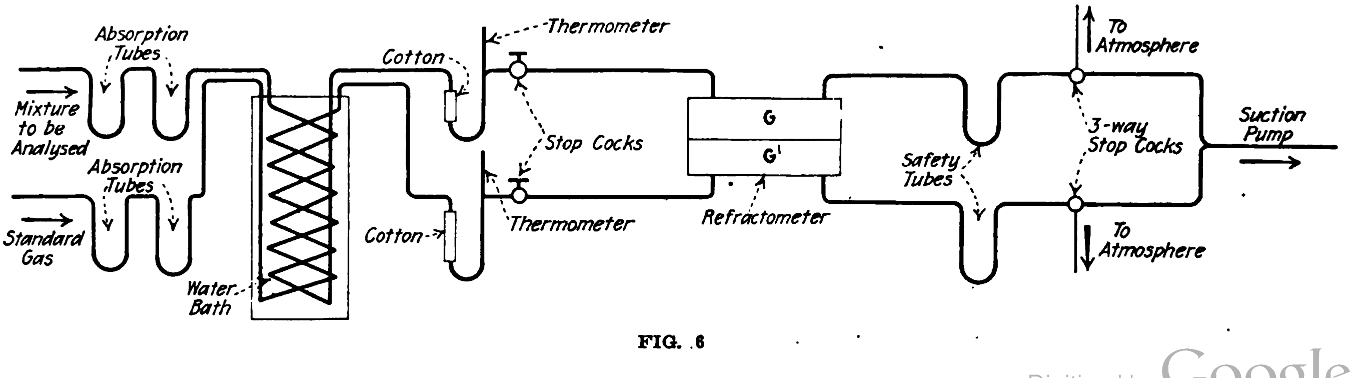

Absorption Tubes
Mixture to be Analysed
Absorption Tubes
Standard Gas
Water Bath
Cotton
Thermometer
Stop Cocks
Thermometer
Cotton
G
G'
Refractometer
Safety Tubes
To Atmosphere
3-way Stop Cocks
To Atmosphere
Suction Pump

FIG. 6

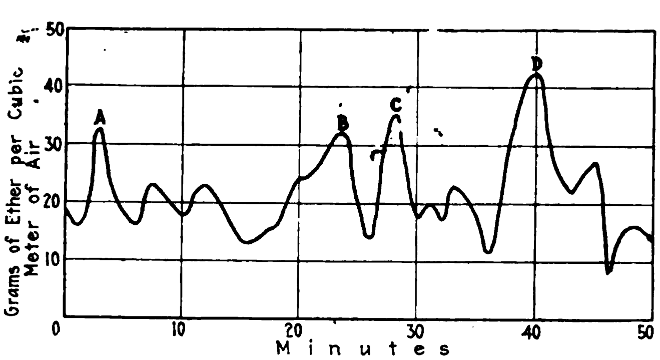


FIG. 7

dices, the relation (3) given for binary gas mixtures becomes

$$N''N'_1 = (N_2 - N_1)\frac{p_2}{d_2a} + (N_3 - N_1)\frac{p_3}{d_3a} \qquad (4)$$

Here there is one relation in which there are two unknown factors, p_2 and p_3. A second relation is required. This can be obtained by absorbing one of the reagents in the absorption tubes, but the operation is impracticable. It can therefore be stated *for mixtures composed of more than two gases, the interferometric method does not present any advantage over the standard volumetric or gravimetric methods.*

In case one of the constituents of a ternary gas mixture is not taken into consideration the problem reverts to the analysis of a binary mixture.

An illustrative example of the value of the interferometric method in the analysis of binary gas mixtures is best shown by the diagram, Fig. 7. This gives the results obtained by interferometric analyses of an ether-air mixture from a nitrocellulose powder factory. The variations in the ether content, although very rapid, are easily recorded. No known chemical method could give similar or nearly similar reliable results.

Calculation of Hydrometer Degrees, Gravities and Weights With the Slide Rule

BY WALLACE SAVAGE

IN THE two hundred and forty-odd years since Robert Boyle designed the first hydrometer, it almost seems that a new modification has made an appearance on an average of once a year. Fortunately the styles that have disappeared have accounted for about two centuries of this time. The remaining twoscore must have some raison d'être to account for their survival. No doubt the hydrometer is the simplest weighing device existent from a mechanical construction point of view. It is based on the principle of Archimedes, viz., *a body immersed in a liquid loses, by virtue of the surrounding particles, a weight equal to that of the liquid displaced by it.*

Archimedes was led to the discovery of this principle while trying to determine whether the new crown of the king of Syracuse was pure gold as represented by the goldsmith or not. Finding that the crown did not bear the 19.3 ratio to water as should be exhibited by pure gold, and was considerably less, Archimedes was able to demonstrate the fraud conclusively. Boyle's problem had a certain similarity. In 1675 counterfeit guineas were quite prevalent in England and the first hydrometer was devised by him with a clip at the base so that the guinea to be inspected could be suspended from the float. Counterfeit guineas were always too light to sink the float to the indicator mark.

CLASSES OF HYDROMETERS

Up to the present time there have been two types of hydrometers—constant volume and constant weight. The former is used mostly for determining the density of solids and is not of industrial importance. Nicholson's apparatus is the classical one. The constant weight hydrometer is used for gravity determinations of liquids and, next to the thermometer, it is the most widely applied instrument in the manufacturing industries. Because of the importance of temperature corrections, a mercury thermometer is often built into the spindle and the instrument is then called a thermo-hydrometer.

Constant weight hydrometers have four types of scales:

Density hydrometers, indicating density of a specified liquid, at a stated temperature, in specified units.

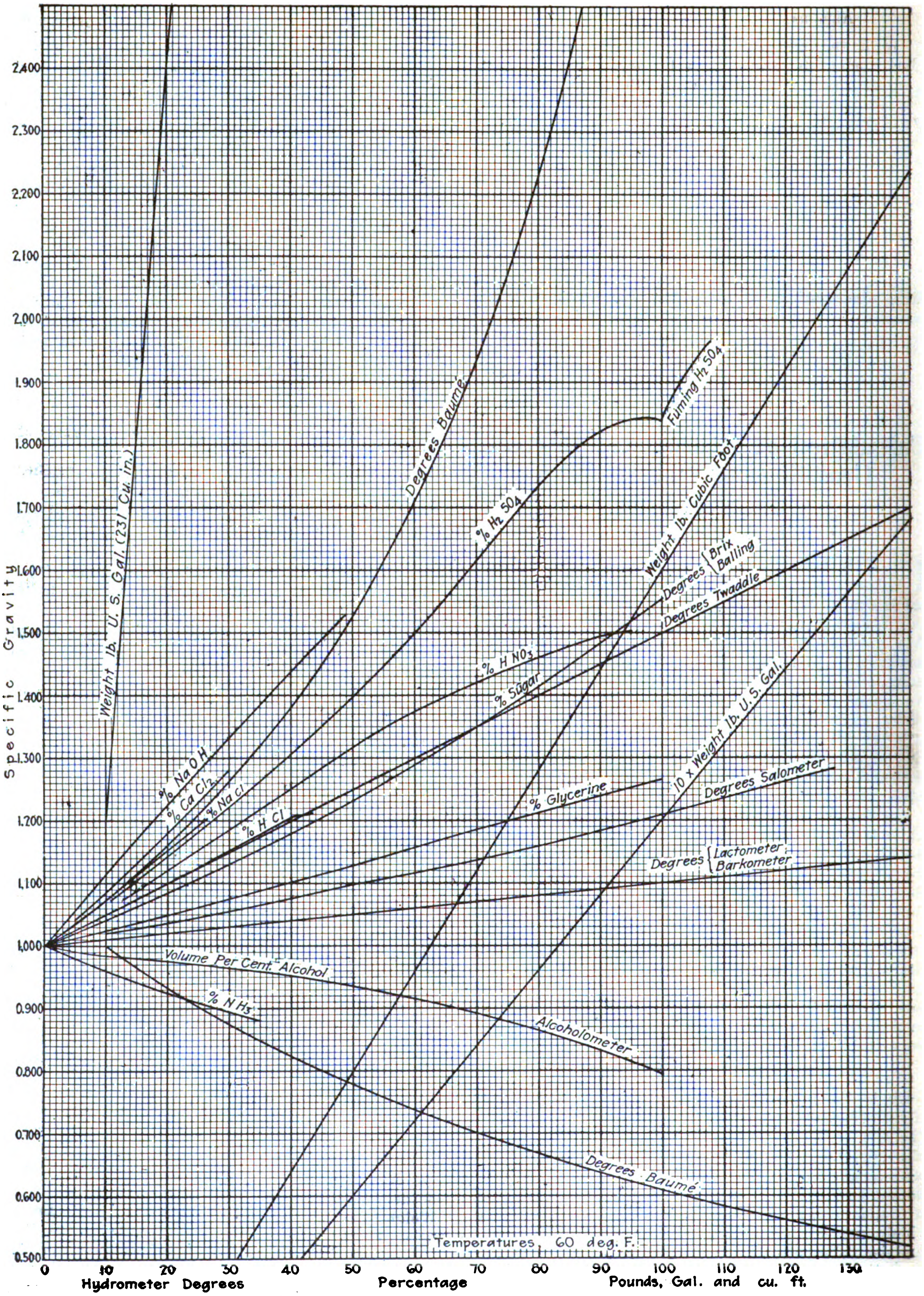
Specific-gravity hydrometers, indicating the relative density of a specified liquid at a stated temperature to water at a stated temperature.

Per cent hydrometers, indicating, at a stated temperature, the percentage of a specified material in its aqueous solution.

Arbitrary scale hydrometers, indicating, at a stated temperature, degrees having an arbitrary but fixed relation to specific gravity.

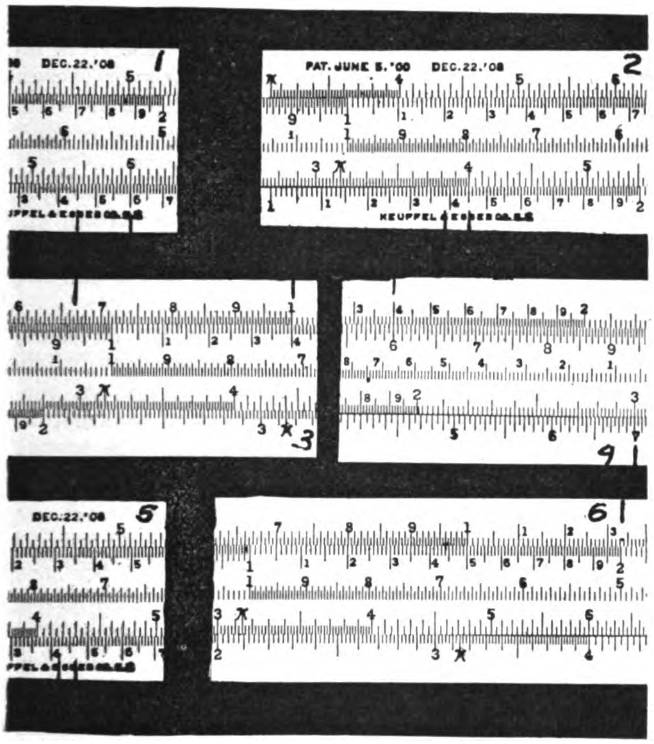
Density and specific-gravity hydrometers need no elucidation. They did not find favor with the old-time instrument makers partly because they have a variable length scale which is difficult to graduate on the stem of the instrument. Halves, quarters, eighths, sixteenths and thirty-seconds or submultiples of 360 were the only paths beaten into the early mathematical instrument realm. To the average mind of the centuries prior to our own, decimal fractions were not even to be considered. Without doubt there is much virtue in the simple integer "degree" scales. For instance take 66 deg. Baumé oil of vitriol. Who would prefer to memorize 1.8354 sp.gr. or try to teach it to acid plant workmen? No doubt the per cent hydrometer is the instrument of the future. However, some substances such as sulphuric acid do not lend themselves well to this type of instrument. In an accompanying chart, several degree scales, solution gravities, etc., have been plotted. From these curves and lines, all the equivalents can readily be obtained.

The first thing to be noticed is that the salts such as sodium hydroxide and the chlorides of sodium, hydrogen, calcium give approximately straight lines and are thus more or less additive. The oxy-acids, such as nitric and sulphuric, exhibit peculiar curves and, due to the compression of solvent, do not take on the expected increments in solution gravity corresponding to the increments in solute mass. Alcohol acts similarly, giving large shrinkages. Usually in the distillery trade, the term degree proof is used and is simply twice the volume per cent. Thus ethyl alcohol of 0.900 sp.gr., is 66 vol. per cent, 132 deg. proof, 25.4 deg. Baumé and weighs 7.5 lb. gal., 56.0 lb. cu.ft.


Specific Gravity
2,400
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
0,900
0,800
0,700
0,600
0,500
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Hydrometer Degrees
Percentage
Pounds, Gal. and cu. ft.
Weight lb. U. S. Gal. (231 Cu. in.)
Degrees Baumé
% H_2SO_4
Fuming H_2SO_4
Weight lb. Cubic Foot
Degrees {Brix Balling
Degrees Twaddle
% HNO_3
% Sugar
% NaOH
% $CaCl_2$
% NaCl
% HCl
% Glycerine
10 x Weight lb. U. S. Gal.
Degrees Salometer
Degrees {Lactometer Barkometer
Volume Per Cent. Alcohol
Alcoholometer
% NH_3
Degrees Baumé
Temperatures, 60 deg. F.

Arbitrary Scale Hydrometer Moduli

With the exception of the Twaddle, Barkometer, Lactometer, etc., scales, the arbitrary scale heavier than water hydrometers of Baumé, Beck, Cartier, Gay-Lussac, Balling, Brix, Fischer, Greiner and Stoppani all fall under the formula Deg. $= M(S - 1) \div S$, where M has a special value for each scale. The former three are more simple, being expressed by the formula Deg. $= M(S - 1)$. The lighter-than-water scales follow logically, having the formula: Deg. $= M(1 - S) \div S$ in the case of all but the Baumé[1] and Cartier scales, where 10 and 10.7 are added respectively to the calculated degrees. See table opposite.



GRAVITY CONVERSIONS ON THE SLIDE RULE

1. 1.60 Specific Gravity = 54.4 Deg. B$_h$U.S.B.S.: $\frac{54.4}{145} = \frac{0.6}{1.6}$
2. 40 Deg B$_h$U.S.B.S. = 1.381 Sp.Gr.: $\frac{40}{145} = \frac{0.381}{1.381}$
3. 20 Deg. B$_l$U.S.B.S. = 0.933 Sp.Gr : $\frac{10\,(+10)}{140} = \frac{0.666}{0.933}$
4. 0.70 Sp.Gr. = 60 Deg. B$_l$U.S.B.S.: $\frac{60\,(+10)}{140} = \frac{0.3}{0.7}$
5. 43 Deg. B$_h$ Gerlach = 1.415: $\frac{43}{146.78} = \frac{0.415}{1.415}$
6. 1.666 Sp.Gr. = 133.2 Deg. Twaddle: $\frac{133.2}{200} = \frac{0.666}{1}$

Unfortunately the most prominent of the arbitrary scale hydrometers, the Baumé, has at least eight values of M. This is a considerable improvement since 1881, when Prof. Charles F. Chandler[2] found '23. In 1904, the U. S. Bureau of Standards adopted 145 and 140 as the moduli of the heavy and light Baumé scales. These are based on 60 deg. F. determinations. Most of the petroleum hydrometers manufactured by Tagliabue in use have a modulus of 141.5. The other heavier-than-water Baumé moduli are 144, 144.3, 145.88, 146.3 and 146.78, varying from 4 to 17.5 deg. C.

The table below gives in the form of proportions the formulæ expressing the relation between specific gravity and hydrometer degrees. The six settings on the slide rule illustrate the application of these proportions with the light and heavy Baumé scales as well as the Twaddle scale. As American chemists will be concerned mainly with the U. S. Bureau of Standards Baumé scale, it should be noted that the value of the modulus is a function of the temperature. By determining the modulus, "m," at any temperature of a d degree liquid, degrees corrected for temperatures can be quickly calculated by setting $d : m :: D : M$.

HYDROMETER DEGREE SLIDE RULE FORMULAE

	Heavier Than Water	Lighter Than Water
Gay—Lussac..........	$\frac{D}{100} = \frac{S-1}{S}$	$\frac{D}{100} = \frac{1-S}{S}$
Cartier..............	$\frac{D+10.7}{126.1} = \frac{S-1}{S}$	$\frac{D+10.7}{126.1} = \frac{1-S}{S}$
Baumé, U. S. B. S......	$\frac{D}{145} = \frac{S-1}{S}$ (60°F.)	$\frac{D-10}{140} = \frac{1-S}{S}$ (60°F.)
Taglibue..........	....	$\frac{D-10}{141.5} = \frac{1-S}{S}$ (60°F.)
"Old Holland".....	$\frac{D}{144} = \frac{S-1}{S}$	$\frac{D}{144} = \frac{1-S}{S}$ (4°C.)
Gerlach..........	$\frac{D}{146.78} = \frac{S-1}{S}$	$\frac{D-10}{146.78} = \frac{1-S}{S}$ (17.5°C.)
Stoppani.............	$\frac{D}{166} = \frac{S-1}{S}$	$\frac{D}{166} = \frac{1-S}{S}$
Beck.................	$\frac{D}{170} = \frac{S-1}{S}$	$\frac{D}{170} = \frac{1-S}{S}$
Balling (not for sugar).	$\frac{D}{200} = \frac{S-1}{S}$	$\frac{D}{200} = \frac{1-S}{S}$
Brix Fischer Greiner } Not for sugar	$\frac{D}{400} = \frac{S-1}{S}$	$\frac{D}{400} = \frac{1-S}{S}$
Twaddle..............	$\frac{D}{200} = S-1$	
Barkometer Lactometer }	$\frac{D}{100} = S-1$	

The slide rule offers a most excellent medium for determining either an unknown modulus from values of D and S or either of the latter, when the two others are given. D can be determined to three significant figures, which is with as good a degree of accuracy as the best hydrometers can be read. Differences in the various Baumé scales are easily determined, as will be observed from the settings given. Some practice will be required in picking out the ratios $(S - 1)/S$ and $(1 - S)/S$ when calculating specific gravities from hydrometer readings. Adding and subtracting constants is also awkward at first. Temperature conversions should be practiced by setting 5 to 9 and reading the corresponding scales less 40. Thus 140 will be found opposite 252 on the scale and by reading 40 less, 100 deg. C. is read equivalent to 212 deg. F. The basis of this method of conversion is the fact that —40 deg. F. corresponds to —40 deg. C.

Weights per gal. or cu.ft. are obtained by setting S over 12 or 16 respectively. Thus 1 gal. of 100 deg. Bark. tanning extract has a sp.gr. of 1.100 and weighs 9.16 lb. One cu.ft. of 54.4 deg. Baumé sulphuric acid, sp.gr. 1.60, weighs 100 lb.

---

[1] Old Holland does not add 10.

[2] National Academy of Science, 1881.

Determination of Maltose Conversions

By F. E. Coombs

IN THE technical production of maltose and malto-dextrine, iodine solution is generally used as an indicator of completed process, but in the writer's experience this has been found highly unsatisfactory.

Its use is limited to establishing in a gelatinized starch solution, or suspension, the point where all of the "normal" starch has been altered; but it by no means shows what part of the starch has gone completely over into maltose when, as is oftenest the case, the desired product is to carry more or less dextrine along with the maltose, and most often some profitable object is attained by carrying a fixed percentage of dextrine and of maltose in the finished material. Further, if raw ground malt has been added to the cooked starch-mass in the converter, a certain amount of raw starch is introduced with it which, at conversion temperatures, is not gelatinized or hydrolized. This persists, and if the iodine reaction is relied upon the process is needlessly prolonged. Polarimetric methods are intricate and too slow for use as control of a going conversion.

Quick and Satisfactory Method

The subject of this paper is a quick and satisfactory technical method for the control of malt-conversions which the writer has found reasonably accurate, capable of use by an average attendant, and which will enable him to stop a conversion at any predetermined ratio of maltose to dextrine.

On starting the conversion and as soon as the contents of the tank are homogeneous, a sample is taken, through a fine brass gauze strainer, into a flask large enough to contain more than a filling for a hydrometer jar. The sample is cooled in the flask under a tap to a standard temperature and a spindle reading taken at that temperature. From a table later described and calculated for some desired balance of maltose-to-dextrine, there is then read off a number of cubic centimeters corresponding to a fixed weight—conveniently 10 g.—of the sample at the observed density, and this volume is then measured with a graduated pipette into a flask, made up to, say, 150 cc. with distilled water, well shaken, and a burette filled to zero with the diluted sample. From the burette a prescribed number of cubic centimeters is run into 10 cc. of freshly mixed, boiling Soxhlet solution and boiled for a minute or two. Should the added volume of dilute sample fail to reduce all of the copper, as indicated by the blue color remaining after the boiling in the clear upper portion of the test, then the conversion is known not to be completed to the required point and is allowed to go on.

Completion of the Test

During progress of the cook, these tests are repeated at intervals judged by the rate of disapparance of the blue color, until a final test shows its entire or almost complete absence, when the conversion is immediately stopped by admitting steam to an ample coil in the converter tank. A small bench near the converter is provided with the needed apparatus, including a rack carrying a series of 10-in. test tubes ready filled with 10 cc. charges of mixed Soxhlet solution. At this bench is posted a typed table showing the constants to be followed in making the tests, such tables being kept in readiness and separate ones made for each material change in the maltose-dextrine ratios that may be wanted from time to time.

Calculation of Tables

The calculation of the tables is simple and is based on the fact that, for practical purposes, the specific gravity influence of the two components, in solution, is the same for the same percentages contained. Each table has three columns, the first showing the range of densities B. in half degrees (or Brix in whole degrees) covering the maximum fluctuation of the converter liquors; a second column shows the number of cubic centimeters equal to 10 g. of a sample at the listed densities; the last vertical parallel column indicates the volume of diluted sample to be run into the Soxhlet tube from the burette, and which will just reduce the copper therein when the total solids are one-half, two-thirds, or whatever is desired in maltose content in the finished product in ratio to the dextrine remaining unconverted.

The test, including taking and cooling the sample, can be made in less than five minutes, is within the ability of any operative intelligent enough to trust with conducting a process kettle, and it will insure uniform composition of the conversion product.

It is recommended that the light provided for doing the reduction test should be a good incandescent (nitrogen-filled) lamp, as in that case the men are not confused in judging the color by changes of weather or alternation from day to night shifts, and once having caught the proper appearance of an exact reduction, this will not vary.

TABLE I—TABLE FOR MALTOSE CONVERTER CONTROL

(Total solids of finished product to contain 50 per cent maltose)

Per Cent Solids (Deg. Brix) Converter Liquor	Volume Converter Liquor = 10 g. cc.	Dilute Liquor From Burette cc.
13.0	9.5	18.6
13.5	9.5	17.9
14.0	9.5	17.5
14.5	9.4	16.8
15.0	9.4	16.2
15.5	9.4	15.6
16.0	9.4	15.1
16.5	9.4	14.6
17.0	9.4	14.2
17.5	9.3	13.8
18.0	9.3	13.5
18.5	9.3	13.1
19.0	9.2	12.8
19.5	9.2	12.5
20.0	9.2	12.2
20.5	9.2	11.8

The general formula for a table such as the one given would be

$$100\left(0.0807 + \frac{\text{Sp. gr.} \times \text{Brix} \times ax}{150}\right) = y$$

In which

0.0807 = grams maltose to reduce 10 cc. Soxhlet solution.
Sp. gr. = Specific gravity of converter contents.
a = Per cent maltose desired in total solids, as a decimal expression.
x = $\frac{10}{\text{Sp. gr.}}$ = cubic centimeters of original converter liquor to be diluted to 150 cc.
and y = Cubic centimeters of diluted liquor to be delivered from burette into 10 cc. of Soxhlet solution, and which will just reduce the copper therein when the predetermined percentage of maltose has been reached.

If the table is to be based on a uniform measured volume of 10 cc. of original converter liquor, then, with the same constants as above, the formula becomes

$$100\left(0.0807 : \frac{10\ \text{Sp. gr.} \times \text{Brix} \times a}{150}\right) = y$$

In the first column of Table I the usual range of densities of the converter liquor is covered, stated as degrees Brix, and assuming that the liquor has been strained carefully and cooled to not above 20 deg. C.

G. L. Spencer's "Handbook for Sugar Manufacturers," edition of 1906, carries a table of specific gravities parallel to degrees Brix, which has been used in the calculation of the table.

If, then, 10 g. be divided by the specific gravity corresponding to, say, 15 deg. Brix (1.061), 9.42 cc. will be found as the nearest equivalent volume, and can conveniently be measured out as 9.4 cc. for a working quantity, and in this way the second column of the table is derived. Having measured this volume and diluted it to 150 cc., each cubic centimeter will represent 0.06667 g. of the original converter liquor, and 0.06667 × .15 (decimal expression of the total solids) will give the weight of the original solids now contained in the diluted liquor, per cubic centimeter, or 0.01 g. And if 50 per cent of the total solids are to be maltose, each cc. of the diluted liquor should contain 0.005 g. maltose when conversion has progressed to the desired stage. And since each measured portion of Soxhlet solution corresponds to 0.0807 g. of maltose, then $\frac{0.0807}{0.005} = 16.14$ cc., or the volume required to be run from the burette to reduce all the copper of the Soxhlet solution. But the burette will not measure closer than 0.1 cc., and if 16.1 is taken, it will be found by retrogressive calculation that $\frac{0.0807}{16.1} = 0.0050124$ g. as the weight of maltese per 1 cc. of the diluted liquor. This weight divided by $\frac{(1.061 \times 9.4)\ .15}{150} = 0.5025$ plus.

In this case decimal errors have been cumulative in one direction, as only tenths of cubic centimeters can be regarded in measurements ordinarily. For this reason, 16.2 cc. is used in the table, and this figure, by the preceding calculation, will give 49.94 per cent maltose, which is close enough for factory purposes. Control tables of this nature must always be checked back and figures empirically altered to conform as nearly as possible to technical needs and the requirements of manipulation.

It is obvious that tables for this purpose may be calculated by taking a uniform volume of the converter liquor instead of a uniform approximate weight—for example, 10 cc.—and that in such a case only two columns are required, since the second one of the tables I have given might be omitted. And it is also clear that such tables will serve as well for the working of acid hydrolysis in dextrose conversion from starch.

San Francisco, Cal.

A Town for Sale

The War Department is offering for sale the town of Nitro, West Virginia, a complete industrial community embracing 737 manufacturing buildings housing accommodations for 20,000 persons and the utilities and civic improvements that constitute the conveniences of a modern city. Nitro, built by the Government at a cost of approximately $70,000,000, is the site of the second largest smokeless powder plant in the world. The bids, which must cover not only the powder plant and the other industrial units which were erected to prepare the ingredients essential to powder making, but the civic community as well, to which the United States also holds title, will be opened at 12 o'clock noon on Sept. 30, 1919, at the office of the Chairman of the Ordnance District Salvage Board, 1710 Market St., Philadelphia, Pa.

Synopsis of Recent Chemical and Metallurgical Literature

Uses of Water Power and Raw Materials in the Metallurgical and Chemical Industries in France.—In the May-June, 1918, issue of *La Houille Blanche* Mr. E. F. CÔTE described at length the bright side of the potential value of the Rhone waterfalls, and gave in conclusion a table on the water power and raw materials used in electrometallurgical and chemical industries. (See Table I.) In the September-October issue of *La Houille Blanche* Prof. GEORGES FLUSSIN, director of the Electrochemical and Metallurgical Laboratory of Grenoble, France, gave another table on the same subject. (See Table II.)

Both authors state that the figures are only approximate and that they vary somewhat with the apparatus used, the method of manufacturing and the composition of the raw materials. Abstracts of these tables are given as representing average French hydro-electric practice.

TABLE I—CONSUMPTION OF HYDRO-ELECTRIC POWER AND RAW MATERIALS IN SOME CHEMICAL AND METALLURGICAL INDUSTRIES (E. F. COTE)

	Per Ton of Manufactured Product		Raw Materials Handled per Kw.-Yr. (Tons)
Products	Kw.-Day (24 Hr.)	Raw Material Handled (Tons)	
Calcium carbide	180	2.5	4.5
Ferrosilicon, 50 per cent	300	3.0	3.3
Ferrosilicon, 80 per cent	650	4.0	2.0
Ferrochrome, 8 per cent	360	4.0	3.7
Ferromolybdemun	360	3.5	3.2
Ferrotungsten	325	3.0	3.0
Usual aluminum	950	4.0	1.3
Amorphous carborundum	700	3.0	1.4
Electrolytic soda	60	6.0	33.4
Electric steel	12	1.2	34.0
Zinc (by electric furnace)	200	5.0	8.0
Zinc (by electrolysis)	180	7.0	13.0
Lead and antimony	120	4.5	12.5
Nickel (from matte)	180	4.0	7.0
Copper (15 per cent ore)	250	9.0	12.0
Copper (refining)	4	1.5	90.0
Carbon sulphide	85	2.4	9.4
Opaque glass products	200	2.5	4.0
Manufacture of electrodes	250	2.5	3.3

TABLE II—CONSUMPTION OF HYDRO-ELECTRIC POWER AND RAW MATERIALS IN SOME CHEMICAL AND METALLURGICAL INDUSTRIES (PROF. GEORGES FLUSSIN)

	Per Kw.-Day (24 Hr.)		Consumption per Ton of Manufactured Product	
Products	Kilograms Obtained	Kilograms of Principal Raw Materials Used	Kw.-Day (24 Hr.)	Raw Materia
Phosphorus	1.1	14 to 22	909	13 to 20
Chlorine	6.0	27	167	4.5
Caustic soda	6.6			
Sodium perchlorate	5 to 7	4.7 to 6.6	200 to 143	0.95
Carborundum	2.8	10	357	3.6
Artificial corundum	9 to 11	18 to 22	111 to 91	2.0
Calcium carbide	5.5 to 6	9 to 10	182 to 167	1.75
Synthetic nitric acid	1.3 to 1.5	..	770 to 667	...
Calcium cyanamide	45	36	22	0.8
Sodium	1.2	3.1	834	2.6
Aluminum	0.8 to 0.9	2.5	1250 to 1111	3.0
Synthetic pig iron	24 to 30	36 to 38	42 to 33	1.3
Steel, solid charge	22	27	45.5	1.3
Steel, liquid charge	120	150	8.3	1.3
Electrolytic iron, with rotating cathode	6	7	167	1.1
Electrolytic iron, with fixed cathode	23	25	43.5	1.1
Ferrosilicons 10 to 12 Si	9.2	14.3	109	1.55
25 to 30 Si	5.8	11.0	172	1.90
45 to 50 Si	3.0	8.7	333	2.90
70 to 80 Si	1.4	6.0	714	4.30
90 to 95 Si	1.0	6.4	1000	6.40
Ferro-manganese 18 to 20 Mn	15	27	67	1.80
70 to 75 Mn	6	19	167	3.15
Ferrochrome 10 per cent C	3.5	10	286	2.90
1 per cent C	1.8	14	555	4.05
Ferrotungsten	2.5 to 3.5	7	400 to 286	2.7
Silico-manganese 10 Si-20 Mn	7.5	16.6	133	2.2
10 Si-70 Mn	4.6	11.4	217	2.5
25 Si-50 Mn	3.0	8.0	333	2.7

Natural and Industrial Resources of France, Germany, Great Britain and Ireland, the United States and the World for 1913.—In a series of articles published by *L'Industrie Chimique* during the months of May to December, 1918, AGRICOLA passes in review the situation of the natural and industrial resources of France, Germany, Great Britain and Ireland, the United States and the world in 1913. The data given form a very valuable source of information on the economic status before the war and no doubt will serve as a basis of comparison in the history of the industrial progress during the pre-war and post-war times. It is noteworthy that the United States produced about 60 per cent of the totals of cereals, cotton, oil, copper, aluminum; about 40 per cent of coal, pig iron, steel, zinc; about 30 per cent iron, lead, silver; about 20 per cent gold, etc., while its population was only about 15 per cent of the world's total.

TABLE I—COMPARATIVE DATA ON ECONOMIC, FINANCIAL AND INDUSTRIAL RESOURCES, 1913

	France	Germany	Great Britain and Ireland	United States	World
Area sq. miles	204,090	208,830	120,979	3,507,640	52,000,000
Area under cultivation, sq.mi	132,600	132,600	74,100	772,200	....
Forests, sq.mi	38,400	33,700	4,860	768,300	....
Population	40,000,000	70,000,000	48,000,000	105,000,000	1,650,000,000
Industrial employees	6,260,000	10,853,000	....	7,000,000	....
Coal mining industry employees	199,000	611,000	1,069,000	723,000	....
Chemical industry employees	33,650	220,000	120,000	149,339	....
Engineers	....	24,500	....	....	....
Chemists	2,500	30,000	5,000	18,000	....
National wealth (million dollars)	68,000	82,600	86,600	223,000	1,940,000
Revenues (million dollars)	6,800	10,200	11,640	29,100	194,000
Taxes (million dollars)	970	776	970	1,160	....
Debt (million dollars)	6,130	4,760	3,380	1,060	....
Army expenses (million dollars)	285	315	139	....	1,555
Navy expenses (million dollars)	106	103	239	....	778
Imports (million dollars)	1,650	2,600	3,810	1,770	....
Exports (million dollars)	1,335	2,440	2,600	2,330	....
Total commerce (million dollars)	2,985	5,040	6,410	4,110	39,800
Railways, miles	31,620	39,600	22,320	236,000	621,400
Merchant marine (net tons)	1,519,000	3,154,000	11,879,000	7,714,000	40,000,000
Steam motive power (hp.)	3,551,000	8,264,000	11,700,000	22,240,000	102,000,000
Hydraulic motive power (hp.)	600,000	445,000	80,000	2,000,000	13,000,000
Factories of chemical products	535	86,999	....	2,856	....
Recuperating coke ovens	2,000	30,000	7,000	8,500	....
Blast-furnaces	112	309	331	206	....
Spindles for cotton	7,400,000	11,400,000	56,000,000	31,500,000	145,000,000
Cotton weavers' looms	110,000	230,000	741,000	633,000	....

TABLE II—COMPARATIVE PRODUCTION OF SOME OF THE MAIN INDUSTRIAL COMMODITIES, 1913—TONS

	France	Germany	Great Britain and Ireland	United States	World
Coal	40,500,000	177,000,000	260,000,000	464,000,000	1,150,000,000
Lignite	793,000	87,000,000	....	....	....
Iron ores	23,250,000	28,600,000	16,250,000	59,400,000	140,770,000
Pyrites	270,000	225,000	11,000	360,000	7,000,000
Phosphate	335,000	....	9	3,202,600	7,500,000
Salt	1,150,000	2,994,000	2,083,000	3,077,000	15,455,000
Petroleum	....	150,000	....	38,500,000	57,920,000
Gas (millions cu. m.)	1,350	2,770	5,550	5,770	22,000
Coke	2,900,000	32,168,600	20,000,000	40,000,000	90,000,000
Pig iron	5,310,000	19,310,000	10,650,000	31,461,600	80,000,000
Steel	4,635,000	17,615,000	7,790,000	31,800,000	....
Zinc	63,500	277,000	58,000	308,500	975,000
Copper	13,000	37,500	68,000	527,600	1,005,900
Lead	53,000	181,000	29,000	386,700	1,185,000
Aluminum	18,000	3,000	7,500	22,500	68,200
Tin	500	12,410	18,350	....	118,200
Sulphuric acid	875,000	1,600,000	1,150,000	2,200,000	10,500,000
Superphosphates	1,920,000	1,818,700	820,000	3,248,000	12,500,000
Ammonium sulphate	68,500	550,000	432,000	155,000	1,300,000
Sodium carbonate	350,000	550,000	750,000	675,000	3,500,000
Potash (K_2O)	6,000	1,100,000	....	8,500	1,126,100
Beet sugar	800,000	2,738,000	....	700,000	9,000,000
Alcohol (hectoliters)	3,100,000	3,750,000	1,193,000	3,650,000	22,900,000
Benzol	12,000	250,000	80,000	90,000	500,000
Cotton	....	....	....	3,210,000	4,750,000
Wool	40,000	20,000	70,000	140,000	1,285,000
Cement	2,300,000	7,200,000	....	15,050,000	35,000,000
Woodpaste	90,000	600,000	....	2,600,000	6,000,000
Cellulose	....	600,000	....	1,600,000	3,500,000
Soaps	....	....	300,000	800,000	....

TABLE III—COMPARATIVE CONSUMPTION OF SOME OF THE MAIN INDUSTRIAL COMMODITIES, 1913—TONS

	France	Germany	Great Britain and Ireland	United States	World
Coal	59,000,000	140,750,000	175,000,000	459,500,000	1,150,000,000
Lignite	795,000	88,145,000	120	....	....
Iron ores	14,600,000	42,500,000	22,750,000	60,750,000	141,000,000
Pyrites	700,000	1,220,000	810,000	1,300,000	7,000,000
Phosphates	1,250,000	1,190,000	535,000	2,120,000	7,500,000
Petroleum	420,000	750,000	530,000	....	58,000,000
Coke	5,500,000	26,350,000	....	37,100,000	90,000,000
Pig iron	5,400,000	18,650,000	9,730,000	30,000,000	80,000,000
Zinc	81,000	232,000	175,700	313,000	975,000
Copper	95,000	225,800	159,400	321,900	1,000,000
Lead	99,000	229,700	199,400	358,200	1,200,000
Aluminum	3,000	12,600	5,000	22,500	70,000
Tin	7,400	18,300	18,400	48,000	120,000
Min. fertilisers	2,850,000	5,700,000	1,160,000	6,000,000	27,000,000
Ph. fertilisers	1,875,000	4,206,000	910,000	4,870,000	12,500,000
Am. sulphate	95,000	400,000	100,000	250,000	1,300,000
Dyes	9,500	15,000	19,000	26,000	125,000
Sodium nitrate	322,115	774,320	143,190	635,905	2,785,000
Potash (K_2O)	40,437	604,283	17,480	248,294	1,125,000
Sugar	750,000	1,615,000	1,870,000	3,350,000	18,500,000
Paper	560,000	1,400,000	1,215,000	....	10,000,000
Rubber	16,000	21,000	15,000	90,000	200,000
Cotton	250,000	384,245	302,281	1,192,300	4,750,000
Wool	189,000	214,000	327,600	214,200	1,285,000

TABLE IV—COMPARATIVE DATA ON THE VALUES OF SOME OF THE MAIN INDUSTRIAL COMMODITIES—1913

(In Million Dollars)

Industries	France	Germany	Great Britain and Ireland	United States	World
Food	2,820	4,560	3,390	7,770	38,800
Textile and tinctorial	845	974	1,584	1,846	8,660
Rubber	90	134	116	349	776
Mining	156	534	642	2,020	....
Metallurgical (except precious metals)	136	388	194	866	1,940
Mineral fertilizers	49	116	27	136	582
Gas	53	105	214	223	835
Fuel	156	866	680	2,450	4,850
Acids	12	23	14	19.4	97
Alkalis	10	19	23	19.4	87
Lime and cement	29	93	.....	233	485
Leather	444	277	139	169	......
Paper	49	78	68	156	582
Glass	39	58	.....	97	......
Ceramics	30	49	.....	165	......
Soaps	49	58	58	156	......
Dyes	4	58	2	3.5	78
Pharmaceuticals	3	10	8	.....	24.3
Synthetic perfumes	3	6	.....	.....	12.6
Pyroligneous products	3	3	0.2	10	19.4

The Rubber Industry.—While the United States, as a result of intensive development of resources within its borders, materially reduced its dependence upon foreign sources of raw material during the war, it is well to remember that there are certain natural products which, for geographic reasons, must be secured from abroad. Chief among these is rubber, and the following tables[1] show the magnitude of our dependence.

The United States in 1917 consumed about 75 per cent of the rubber used in the world, as shown by Table I.

TABLE I—THE CONSUMPTION OF CRUDE RUBBER
(Long Tons)

Year	United States	Great Britain	France	Germany	Italy	Total
4910	42,210	20,455	3,799	13,775	2,201	82,440
1911	38,475	16,736	5,398	15,281	2,691	78,581
1912	52,964	18,724	4,633	15,643	3,872	95,836
1913	52,179	25,276	6,500	15,500	2,000	101,455
1914	61,251	18,549	5,000	11,000	4,000	99,800
1915	96,792	15,072	10,770	6,000	6,580	135,214
1916	116,477	26,760	14,685	3,000	8,552	169,474
1917	177,088	25,983	17,000	2,000	6,946	229,017

During 1917 Far Eastern plantations produced about 79.5 per cent of the world's supply of crude rubber; the British colonies turned out approximately 80 per cent of this, or 63 per cent of the total production of the world. The only American possession suitable for the growing of rubber is the Philippines, and they produced the insignificant total of 147 tons in 1917, or sufficient to last one of the large American manufacturers about one day.

Table II shows the world's production of crude rubber from 1900 to 1919, inclusive, the quantities being given in long tons (2240 pounds), and the statistics for plantation and Brazil rubber being given separately.

TABLE II—PRODUCTION OF CRUDE RUBBER

Year	Plantation	Brazil	Other Kinds	Total
1900	4	26,750	27,136	53,890
1901	5	30,300	24,545	54,850
1902	8	28,700	23,632	52,340
1903	21	31,100	24,829	55,950
1904	43	30,000	32,077	62,120
1905	145	35,000	27,000	62,145
1906	510	36,000	29,700	66,210
1907	1,000	38,000	30,000	69,000
1908	1,800	39,000	24,600	65,400
1909	3,600	42,000	24,000	69,600
1910	8,200	40,800	21,500	70,500
1911	14,419	37,730	23,000	75,149
1912	28,518	42,410	28,000	98,928
1913	47,618	39,370	21,452	108,440
1914	71,380	37,000	12,000	120,380
1915	107,867	37,220	13,615	158,702
1916	152,650	36,500	12,448	201,598
1917	204,251	39,370	13,258	256,879
1918*	210,000	38,000	12,000	260,000
1919*	240,000	38,000	12,000	290,000

*Estimated.

Indications are that plantations will henceforth furnish an increasing proportion of the world's supply of crude rubber. The difficulties of producing wild rubber in sufficient quantities in Brazil and other districts, together with its high cost of production and the superior, clean condition of plantation rubber, render the gathering of wild rubber disadvantageous compared with plantation rubber. It is said that the cost of production of plantation rubber averages approximately 25c. gold per lb. f.o.b. Far East, whereas Up River fine cannot be produced profitably under 55c. per lb. f.o.b. Brazil.

It is notable that 76 per cent of planted acreage of plantation rubber is owned by British capital, and 2.8 per cent by American capital, according to best available authorities, as shown by Table III.

TABLE III—OWNERSHIP OF PLANTATIONS

Plantation Interests	Acreage	Per Cent
British	1,513,576	75.9
Dutch	260,000	13.0
French and Belgian	100,000	5.0
American	55,000	2.8
German	3,400	0.2
All other	63,577	3.1
Total	1,995,553	100.0

The 55,000 acres planted and controlled by American capital comprise the estate of the General Rubber Co., in Sumatra. American interests have also recently acquired 40,000 acres of undeveloped land in Sumatra. A very limited area is also planted to rubber in Mindanao, Philippines.

A graphic idea of the growth of the plantation rubber industry may be derived from Table IV, giving the estimated acreages in bearing, number of tons production, number of pounds per acre, and the percentage of increase for the years 1900 to 1922, inclusive. The estimates of acreage in bearing for 1920, 1921 and 1922 are based upon present planted acreage, additional areas of which will become productive.

TABLE IV—GROWTH OF PLANTATION RUBBER INDUSTRY

Year	Estimated Acreage in Bearing	Tons	Increase, Per Cent.	Lb. per Acre Planted	Lb. per Acre In Bearing
1900	....	4	...	...	...
1901	....	5	25	...	...
1902	....	8	60	...	...
1903	....	21	162	...	...
1904	....	43	104	...	...
1905	....	145	237	3	...
1906	....	510	251	5	...
1907	....	1,000	96	5	...
1908	....	1,800	80	7	...
1909	....	3,600	100	11	...
1910	93,205	8,200	127	20	197
1911	237,240	14,419	75	26	136
1912	402,912	28,518	98	44	158
1913	345,385	47,618	66	66	195
1914	681,355	71,380	47	92	234
1915	885,079	107,867	51	133	273
1916	1,200,407	152,650	41	183	280
1917	1,448,033	204,251	34	229	316
1918	1,611,124	....	...	...	...
1919	1,727,820	....	...	...	...
1920	1,729,795	....	...	...	...
1921	1,915,553	....	...	...	...
1922	1,995,553	....	...	...	...

Rubber is perhaps the only important staple which has not experienced an increase in price during the period of the world war. The reason is at once apparent from a study of the figures given in Table IV. Large acreages, planted years before, began to bear during the war period, so that production not only kept pace with the increasing demand, but actually exceeded it, resulting in lower prices. Table V shows the downward trend of the price of crude plantation hevea, first latex crêpe, in the New York market.

TABLE V—PRICE OF CRUDE PLANTATION RUBBER[2]

	Dollars per Lb. Jan.	Apr.	July	Oct.
1913	1.10	0.95	0.70	0.52
1914	0.56	0.63	0.55	0.61
1915	0.86	0.62	0.63	0.59
1916	0.92	0.82	0.58	0.61
1917	0.80	0.80	0.67	0.63
1918	0.57	0.60	0.63	0.59
1919	0.55	0.49	0.40	....

[2] *Commerce Monthly* (National Bank of Commerce, New York), September, 1919

A fraction over 66 per cent of all rubber plantations are situated in British colonies, so that Great Britain exercises both political and financial control over the supply of this important raw maaterial. Of the total acreage under British control, 807,491 acres are in the Federated Malay States and Johore, 159,500 acres in the Straits Settlements, 251,500 in Ceylon, 41,820 in South India, 29,880 in British Borneo, 26,390 in British Burma, and 5000 in the South Sea Islands. Under the Dutch flag there are 352,455 acres in Sumatra, 238,830 acres in Java, and 10,100 acres in Dutch Borneo, giving the Netherlands political control over 49 per cent of the total world acreage in rubber plantations. France controls 10,000 acres in Cochin China, and the share of all other countries amounts to 62,577 acres. An almost unlimited area of desirable land for rubber plantations is yet available for development in Sumatra and Borneo; but such is not the case with the Malay Peninsula, Ceylon and Java.

---

[1] Commerce Reports, Aug. 1, 1919, pp. 668-671; Crude Rubber Prices, by Isador Lubin, Price Bulletin No. 30, War Industries Board (reprinted in *India Rubber World*, Sept. 1, 1919, pp. 685-688).

The only place on American soil where conditions have been found favorable to rubber growing is the Philippine Islands, where about 147 tons were produced in Mindanao in 1917, but owing to an insufficient supply of good cheap labor (our Government prohibits the importation of Chinese coolies) and Government restriction limiting the amount of land which corporations can own to 2500 acres, the investment of American capital has been restricted and discouraged.

Metallurgical Calculations.—ADOLPH BREGMAN gives in the August, 1919, issue of *The Metal Industry*[1] an interesting note on the causes of inefficiency of melting appliances, with special reference to an oil-fired furnace. He illustrates by an example how this can be eliminated, and dwells on the necessity of preliminary calculations for an appropriate furnace. "It is an old story that it is far cheaper to change the plant on paper before it is built than after."

The data to be figured out for a given furnace which has to perform a given work are: The amount of heat needed, which is to be expressed in amount of fuel, and the air required for efficient combustion. From these data to determine the best adaptable conditions for efficient performance of the installation.

To take a definite problem:

Given a furnace which must melt 2000 lb. of copper; 4 heats per 8 hours; charging and tapping time ½ hr. per heat, i. e. 1½ hr. for actual melting time.

The theoretical heat necessary to melt a charge is given by

$$\text{B.t.u.} = A \times B \times (T_1 - T)$$

in which A = number of pounds of metal
B = specific heat of the metal
T = temperature of the metal before charging
T_1 = temperature of the metal when ready to tap

For copper $A = 2000$, $B = 0.095$. With $T = 60$ deg. F. and $T_1 = 2700$ deg. F., we have

$$\text{B.t.u.} = 2000 \times 0.095 \times (2700 - 6) = 501{,}600$$

With a factor of safety, or with a furnace efficiency of x per cent, the actual heat units required will be $501{,}600 \div x$. The actual factor of safety is to be considered according to local conditions. With x = say 15, the actual heat units required will be $501{,}600 \div 0.15 = 3{,}344{,}000$ B.t.u.

Using as fuel an oil of say 140,000 B.t.u. per gallon the amount required will be $3{,}344{,}000 \div 140{,}000 = 23.9$ gallons.

The time limit for a melt being 1½ hr., the consumption of oil per hour will be, say, 16 gal. The oil pump and burners must be carefully chosen for size and ease of adjustment. To burn the oil efficiently a well defined amount of air is required. The chemical reactions of combustion are:

$$\begin{array}{ccccc} C & + & O_2 & = & CO_2 \\ 12 & & 32 & & 44 \\ H_2 & + & O & = & H_2O \\ 2 & & 16 & & 18 \end{array}$$

i.e., one part C requires 2.67 parts O and one part H requires 8 parts O.

The oxygen content of the air being 23.1 per cent by weight, the amount of air required will be: $2.67 \div 0.231 = 11.55$ lb. per lb. of C and $8 \div 0.231 = 34.64$ lb. per lb. of H. For practical purposes the average composition of fuel oil may be taken as 85 per cent C and 12 per cent H, the remainder being sulphur, nitrogen, etc., which need not be considered here. With this grade of oil the total amount of air per lb. of fuel is $A = (11.55 \times 0.85) + (34.64 \times 0.12) = 13.97$, say 14 lb.

Taking 7.5 lb. oil per gal., the theoretical weight of air required per gal. of oil is $7.5 \times 14 = 105$ lb. One lb. of air at sea level at 60 deg. F. is equivalent to 13.14 cu.ft., and 105 lb. corresponds to $105 \times 13.14 = 1379.7$, say 1380 cu.ft. This figure represents the theoretical volume of air necessary to burn 1 gal. of oil. In actual practice it takes from 10 to 20 per cent more air to do the work. In order to be quite safe, one should allow 2000 cu.ft. of free air at ordinary temperature for every gallon of oil to be burned. With 16 gal. of oil per hour, we need $2000 \times 16 = 32{,}000$ cu. ft., i. e., $32{,}000 \div 60$ = say, 533 cu.ft. air per minute.

The blower must be of sufficient size to handle the capacity. There is no fixed oil or air pressure for all burners. This can be determined only by the needs of the particular burner used. A logical use of air and oil gages will solve this problem.

It is excellent practice to preheat the oil to a temperature of about 20 to 25 deg. below the flash point. When using heavy crude oil this is absolutely necessary. Air also should be preheated to the temperature of the oil. It must be remembered, however, that if the air is heated due allowance must be made for its expansion and the consequent dilution as regards the proportion of oxygen. This can always be calculated from the formula

$$W = 0.080728 \times \frac{P \times 491.6}{14.6963 \times T \times 459.6}$$

in which W = weight of cu.ft. of air
P = barometric perssure in lb. per sq.in.
T = temperature in degrees F.

In addition the air, especally at low pressure, loses much of its pressure if it has a long travel. It is best to eliminate all avoidable bends and elbows.

Recovery of Zinc From Low-Grade and Complex Ores.—The Bureau of Mines Salt Lake City Station has co-operated with the Department of Metallurgical Research of the University of Utah in studying the possibility of devising new processes for the recovery of zinc from ores. Certain ores too low grade or complex to permit of profitable treatment by the retort process have been the subject of the research reported in Bulletin No. 168, Bureau of Mines, by DORSEY A. LYON and OLIVER C. RALSTON. The work reported in this bulletin covers only the concentration of zinc ores and the hydrometallurgy of zinc. Sulphide and oxidized ores were studied. Investigation included concentration tests by gravity and flotation; chloridizing sulphate, oxidizing and magnetic roasting; acid and alkaline leaching; precipitation of the metal both electrolytically and chemically. Tests were made to determine the suitability of the ores to concentration by igneous and magnetic processes.

---

[1] Adolph Bregman, "Metallurgical Calculations," *Metal Ind.*, vol. 17, No. 8, August, 1919, pp. 369-370.

Acyclic and Saturated Cyclic Hydrocarbons.—The June 30, 1919, issue of *Comptes Rendus* contains the results of the work of Messrs. G. CHAVANNE and J. L. SIMON on the preparation and the critical temperature of dissolution in aniline of some acyclic and saturated cyclic volatile hydrocarbons contained in petroleum distillates. They have studied the following products: Acyclic carbides: normal pentane and isopentane, normal hexane and isohexane, synthetic isohexane. isopentane, heptane, and octane. Saturated cyclic carbides: cyclohexane, methylcyclohexane, the three dimethylcyclohexanes, cyclopentane and methylcyclopentane. They also state that the use of manganous carbonate as a catalytic agent has proved to be particularly efficient in the transformation of butyric, adipic and methyladipic acids into the corresponding acetones (*Compt. Rend.*, T. 168, No. 26, June 30, 1919, pp. 1324-1326).

Recent Chemical and Metallurgical Patents

Complete specifications of any United States patents may be obtained by remitting 5c. each to the Commissioner of Patents, Washington, D. C.

Manufacture of Manganese Steel.—SIR ROBERT HADFIELD of Westminster, England, has developed a high silicon manganese steel which, when heated to between 900 and 1050 deg. C. and then quenched in water, is particularly suitable for use in helmets, body shields and as protective armor for aircraft. Sheets of the following composition when toughened have been found of superior quality: Fe 84.08 per cent, C 1.04 per cent, Si 1.42 per cent, Mn 12.65 per cent, Cr 0.81 per cent. Aluminum may replace silicon up to about equal parts of each, and nickel, cobalt, vanadium, tungsten or titanium, or a combination of these elements, may be used to modify or improve the qualities of the alloy. (1,310,528, July 22, 1919.)

Chloroform From Carbon Tetrachloride.—The present invention relates to certain improvements in the process of manufacturing chloroform described by A. W. SMITH in U. S. P. 753,325. That process involved the separate production of carbon bisulphide and sulphur dichloride, the interaction of these substances to produce carbon tetrachloride and the reduction of carbon tetrachloride to chloroform by agitating with finely divided metallic iron in a suitable reaction vessel. The principal reaction taking place is that indicated by the following equation:

$$2CCl_4 + 2H_2O + 2Fe = FeCl_2 + Fe(OH)_2 + 2CHCl_3$$

The temperature during this reaction must, however, be carefully controlled, since, if allowed to rise, the chloroform is also reduced:

$$2CHCl_3 + 2H_2O + 2Fe = FeCl_2 + Fe(OH)_2 + 2CH_2Cl_2$$

At such higher temperatures, other decomposition products of carbon tetrachloride are also formed. The method first employed consisted in placing the mixture of carbon tetrachloride and water in a double-walled vessel provided with means for circulating water between the two portions of the shell so that the temperature could be kept at about 20 deg. C. Iron filings were then added in successive small portions. It was found, however, that, working at a temperature low enough to prevent the formation of appreciable quantities of dichlormethane, the speed of reduction was extremely slow. Using a higher temperature, the yield was considerably lower due to over-reduction and the possibility of over-reduction increased directly with the amount of chloroform present, so that it was impractical to reduce more than 50 per cent of the carbon tetrachloride. At this point, the temperature was raised and the mixture of CCl_4, $CHCl_3$, CH_2Cl_2, etc., distilled off, yielding in impure chloroform which had to be treated by an expensive process of fractional distillation.

HERBERT H. DOW and WILLIAM O. QUAYLE have found that many of these difficulties may be avoided by using diminished pressure so that the chloroform, as formed, distills off with a certain amount of CCl_4, which is easily separated in the condenser and returned to the reaction chamber. The rapid removal of the $CHCl_3$ from the reaction zone minimizes the opportunity for further reduction and consequently a higher temperature may safely be used, thus increasing the speed of the reaction. Furtherfore, all of the iron or other reducing agent may be added at one time. (1,311,329; assigned to the Dow Chemical Co.; July 29, 1919.)

Method of Removing Certain Impurities From Electrolytic Cells.—HUGH K. MOORE of Berlin, N. H., notes that the gelatinous compounds of calcium and magnesium which deposit in the interstices of the cathode and form on the diaphragm of an electrolytic chlorine cell may be decomposed by filling the anode compartment of the emptied cell with a dilute solution of lactic acid. This acid solution is fed continuously to the cell through the usual float valve, washing the soluble reaction products away from the diaphragm, the cell being by-passed during the operation. The acid forms water-soluble lactates of calcium and magnesium, and the 0.8 per cent solution recommended is not of sufficient strength to dissolve iron to any appreciable extent. (1,309,214, July 8, 1919; assigned to the Brown Co. of Berlin, N. H.)

Separation of Materials by Gravity.—RICHARD L. LLOYD of New York City finds that the slag losses of metals or of matte can be reduced fully one-sixth by specially designed forehearth. In this hearth the incoming material is conducted to the bottom of the hearth, and the slag, rising upward through the metal or matte, is washed of metal values. The entire contents of the hearth are also agitated, assisting in the recovery. (1,310,998, July 22, 1919; assigned to the Dwight & Lloyd Metallurgical Co. of New York.)

Automatic Tempering-Machine for Tools.—CLARENCE O. STEE and KARL H. KOLHEDE of Cerro de Pasco, Peru, take advantage of the fact that tool-steel heated above its critical temperature is non-magnetic in designing an automatic machine for tempering tools. The apparatus consists of an electromagnet arranged as the weight of a pendulum; when the steel is above the critical temperature the electromagnetic pendulum controls the support upon which the heated tool to be tempered is placed. As the tool cools, becoming magnetic, the electromagnet is attracted to the tool, swinging far enough to make a contact, which in turn energizes a second electromagnet. This magnet releases the support which holds the tool, thereby dropping it into the quenching bath. The apparatus is designed primarily for tempering rock-dills. (1,311,722; July 29, 1919.)

Treatment of Ores for Production of Metal and of Potassium Compounds.—CHARLES CUTLETT of Staunton, Va., increases the recovery of potassium in a soluble form from iron blast-furnaces or from other blast-furnaces where the ore contains potassium compounds, by adding salt in small amounts to the charge. The addition of calcium fluoride also tends to produce a slag containing a smaller amount of potash. The volatilized potassium compounds, in this case the chloride, are recovered from the fume and dust by the usual methods. (1,311,043, July 22, 1919; assigned to the British Potash Co., Ltd., of London.)

Apparatus for Extracting Metals From Their Ores.—EDMUND S. LEAVER of Tucson, Arizona, uses sulphurous acid as a leaching agent, in a rotating drum of special construction, for treating ores which contain copper oxides or carbonates. The pulverized ores, in the form of pulp, containing about 5 per cent solids, is fed in at the opposite end of this drum from the SO_2 gases, and the flow of pulp and gases so controlled that the temperature of the discharged pulp is about 40 deg. C. At this temperature SO_2 is but slightly soluble in water. The gases carry an excess of oxygen, which oxidizes the sulphites to sulphates. The discharged pulp therefore contains the metals as sulphates and the exit gases are low in SO_2. The construction of the apparatus is shown in the figures. Fig. 1 is a longitudinal section. The gases from the sulphur burner or roasting furnace 6 are forced by fan 7 into the drum 1, which revolves on trunnions 2. The pulp is fed in and excess gases pass out through 3. The drum is fitted with partitions 17, perforated as at 19 and 20 in Fig. 2. Buckets 13 are provided on the inner circumference of the drum which lift the pulp and dump it on the slats, shown in section 24, by the revolution in direction of the arrow. (1,312,488, Aug. 5. 1919; one-half assigned to Chas. E. Van Barneveld.)

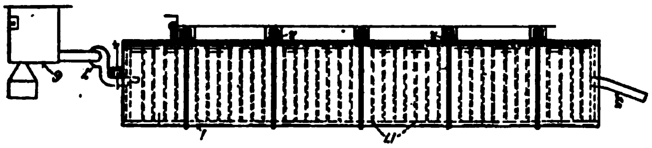


FIG. 1

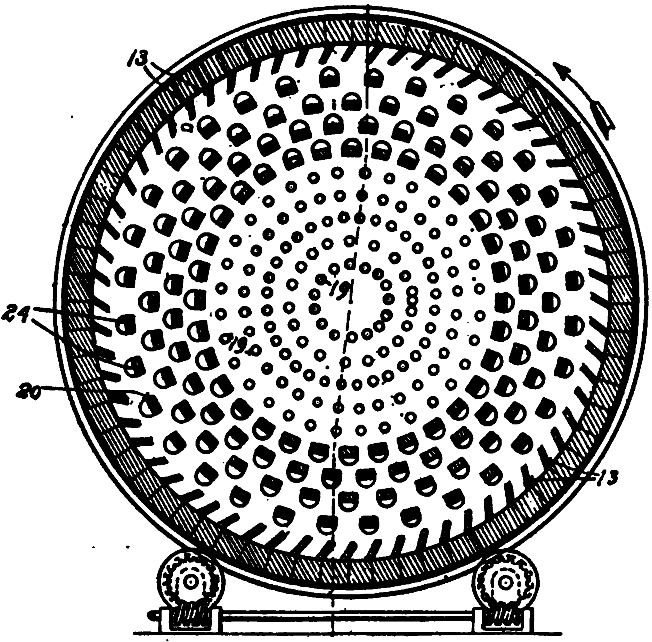


FIG. 2

British Patents

Complete specifications of any British patents may be obtained by remitting 25c. each to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Alkali Dichromates.—An alkali chromate solution is treated with carbonic acid and ammonia, preferably in the presence of ammonium carbonate in excess. Sodium bicarbonate is precipitated and removed, and the solution is then heated to remove ammonia and ammonium carbonate, and lime is added to produce calcium chromate, after which the liberated ammonia is removed by distillation. Niter cake is then added to produce alkali, dichromate and calcium sulphate, the latter being removed by filtration. (British Patent No. 122,172—1918. SOCIÉTÉ INDUSTRIELLE DE PRODUITS CHIMIQUES. Paris, March 19, 1919.)

Lead Chromate Pigments.—Basic lead acetate solution prepared from lead and acetic acid is purified by stirring with chalk or other agent that will absorb lead oxide, and the clear solution is used for the production of lead chromate pigments. Examples are given of the production of lemon chrome from purified lead acetate, acetic acid, sodium bichromate, sulphuric acid, alum and sodium sulphate, and middle chrome from purified lead acetate, acetic acid and sodium bichromate. (British Patent 123,841—1918. E. F. MORRIS, Holly Bank, Roby, near Liverpool. May 7, 1919.)

Albumens.—Soluble decolorized albumens are obtained from blood by first treating it for a considerable time will dilute acid, then adding hydrogen peroxide and allowing this to act for a considerable time, and finally neutralizing the added acid, all at ordinary temperature. Defibrinated blood is preferably used. The product may be evaporated to dryness in vacuo without losing its solubility. Instead of blood, blood cake or the like may be used. (British Patent 123,971—1918. A. J. L. TERWEN, 22 Aaksen Weimarlaan, and C. J. C. VAN HOOGENHUZZE, 8 Baustraat—both in Amsterdam. May 7, 1919.)

Treating Copper Waste. — Copper sweepings and scraps containing copper, zinc, iron, tin, antimony, silica, or other impurities, are roasted with not less than 15 per cent of common salt, silica being added if the amount present in the material to be treated is less than 25 per cent. The roasting is carried out in a two-part furnace comprising a muffle surmounted by a reverberatory furnace. Cupric or cuprous chloride is formed according to whether the roasting temperature is below or above 600 deg. C. The cupric chloride is recovered by leaching with dilute sulphuric acid or the cuprous chloride by volatilization and condensation. (British Patent 123,418—1918. C. C. CITO, 10 rue Henri Marichal, Bruxelles. April 16, 1919.)

Purifying Aluminum Salts.—Aluminum salt solutions, particularly the nitrate, are purified from iron by treatment with excess of amorphous or precipitated alumina, which may be prepared in situ by adding a soluble base to the solution, or an aluminum compound such as calcined kaolin, clay, raw or calcined bauxite, labradorite, or anorthite. The treatment is preferably effected with heat and may be under pressure or otherwise. The solution may be stirred, or air may be blown through. Part of the iron may be precipitated by treatment with one of the minerals mentioned and the rest by precipitated alumina. The last traces of iron may be removed by ferrocyanide, the blue precipitate being absorbed in the first precipitate. If the iron is not in the ferric condition it is first oxidized. (British Patent 123,720—1918. **Norske Aktieselskab for Elektrokemisk Industri**, Norske Industri-Hypotekbank, 1, Bygdö Allé, Christiania. April 30, 1919.)

Alumina.—Kaolin, clay marl, halloysite shale and the like calcined at about 500 deg. C., preferably in a reducing atmosphere, and then treated with nitric acid, or with nitrogen oxides and steam or water. The aluminum nitrate solution is separated from the residue and treated to obtain alumina, e.g., by calcining or by precipitation with ammonia. (British Patent 122,623—1918. **Norske Aktieselskab for Elektrokemisk Industri**, Norske Industri - Hypotekbank, 1, Bygdö Allé, Christiania. Not yet accepted. March 26, 1919.)

Personal

Col. E. H. **Abadie** has been appointed comptroller of the Division of Operations, U. S. Shipping Board, vice Mr. **John J. Nevin**, resigned.

Mr. J. F. **Bartholomew** has accepted the position as chief chemist with the Charlotte Chemical Laboratories, Inc., Charlotte, N. C., having formerly been chemical engineer for the Air Nitrates Corp., Muscle Shoals, Ala.

Dr. D. C. **Byers** of the University of Washington has been appointed chief of the Division of Chemistry in the Bureau of Soils, Department of Agriculture, Washington.

Prof. H. C. **Coles**, who had charge of industrial chemistry at the College of the City of New York during the absence of Professor Moody, has resigned to accept a position as metallurgical expert with the Niles Tool Works Co., New York.

Dr. **Charles H. Herty**, editor of the *Journal of Industrial and Engineering Chemistry*, sailed on Sept. 3 for Europe. Dr. Herty has been appointed by President Wilson to secure America's share of German dyes which by the terms of the Peace Treaty passed to the control of the Reparations Commission. Dr. Herty will endeavor to secure a six months' supply of vat dyes to fill the needs of consumers until vat dyes of American manufacture are on the market.

Mr. **Walter K. Mallette** has been selected to head the engineering department of the Copper Queen Branch of the Phelps Dodge Corporaton and left San Francisco recently for Douglas, Ariz.

Mr. **Paul D. V. Manning**, formerly chemist with the nitrate division of the Ordnance Department, his last assignment being at the Fixed-Nitrogen Research Laboratory, American University, Washington, D. C., has accepted a position as electrometallurgist with the Chile Exploration Co., New York City.

Dr. **Charles L. Parsons**, chief chemist of the Bureau of Mines, has resigned, and it is reported that he will enter private practice.

Dr. **Charles L. Reese** of the du Pont Company and Dr. H. S. **Miner** of the Welsbach Company, each received the honorary degree of Sc.D. from the University of Pennsylvania, this summer.

Dr. **James H. Ransom** resigned as director of the chemical department of Vanderbilt University, last May, and has accepted a position as research chemist with the Michigan Smelting & Refining Co., of Detroit.

Mr. **Charles H. Repath** is at the Calumet & Hecla works at Lake Linden, Michigan, in a consulting capacity.

Dr. **Theodore W. Richards**, professor of chemistry at Harvard University, has been elected president of the American Academy of Arts and Sciences.

Dr. W. H. **Rodebush** has left the research laboratory of the U. S. Industrial Alcohol Co., South Baltimore, Maryland, to take a National Research Council Fellowship at the University of California, Berkeley, California.

Mr. A. A. **Schneider**, formerly with the Raw Materials Department of the Midvale Steel & Ordnance Co., and the Cambria Steel Co., has been appointed manager of the newly created Raw Materials Division of the American Steel Export Co.

Dr. F. W. **Skirrow**, for the past four years assistant professor of chemistry at McGill University, has resigned this position to take up the duties of chief chemist to the Shawinigan Laboratories, Ltd., the newly founded research organization of the Shawinigan Water and Power Co., Shawinigan Falls, Quebec.

Mr. E. E. **Thum**, who has been stationed in Salt Lake City, Utah, since Jan. 1, 1918, as Western Editor of **Chemical & Metallurgical Engineering**, has been transferred to the main editorial office in New York City, and will act as Associate Editor. The new Western Editor is Mr. L. W. **Chapman**, whose headquarters are in San Francisco.

Mr. C. H. **Wildridge** has accepted a position with the Manitoba Steel Foundries at Selkirk, Manitoba. He was formerly with R. W. Hunt & Co., Montreal.

Current Market Reports

The Non-Ferrous Metal Market

Tuesday, Sept. 9.—No important fluctuations in market prices have taken place in the last two weeks, with the exception of zinc, which declined. Sellers are firm, volume of sales is not large, but European buyers are said to be making preparations for important deals.

Aluminum:—Transactions are largely made on direct contract between producer and consumers. The open market is not active; 98-99 per cent ingots are quoted at 32-33c. per lb., remelt at 31-32c. Scrap casting, 21-24c.; sheet scrap, 22½-23c., and clippings, 24-27½c.

Antimony:—The market is easy; spot wholesale is quoted at 8¾c. and futures at 8c. lb. Small job lots, 9c. lb.

Copper:—Some resale copper is being sold at 22½c, but the market price is 23½c. lb. for September and 24c. for October.

Copper sheets, hot-rolled	lb.	33.50 —	......
Copper sheets, cold rolled	lb.	35.00 —	......
Copper bottoms	lb.	41.50 —	......
Copper rods	lb.	24.00 —	......
Copper wire	lb.	26.00 —	......
High brass wire and sheets	lb.	27.75 —	......
High brass rods	lb.	26.75 —	......
Low brass wire and sheets	lb.	30.50 —	......
Low brass rods	lb.	31.25 —	......
Brazed brass tubing	lb.	39.00 —	......
Brazed bronze tubing	lb.	44.25 —	......
Seamless copper tubing	lb.	37.50 —	......
Seamless bronze tubing	lb.	40.00 —	......
Seamless brass tubing	lb.	36.00 —	......
Scrap, heavy machinery comp		17¾ —	18¾
Scrap, heavy and wire		17¾ —	18¾
Scrap, light and bottoms		15¾ —	16¾
Scrap, heavy, cut and crucible		19 —	20
Scrap brass, heavy		10½ —	11½
Scrap brass, casting		12 —	13
Scrap brass, light		9¾ —	10¾
Scrap, No. 1 clean brass turnings		10¾ —	11¾
Scrap, No. 1 comp. turnings		16 —	16¾

Lead:—The lead market is stronger, spot New York being 5.9-6c. lb. and East St. Louis 5.75c. lb. Cut lead sheets are bringing 9c.

Tin:—The tin market has not gathered the expected momentum downward. Straits spots are quoted at 56½c. and 99 per cent electrolytic, 55⅝c. lb.

Zinc:—Spot zinc has declined, but futures are quoted on a rising rate. Spot New York, 7.65c. lb.; October, 7.7c. East St. Louis spot, 7.3c.; October, 7.35c.

OTHER METALS

Bismuth	lb.	$2.95 —	......
Cadmium	lb.	1.50 —	1.75
Cobalt	lb.	2.50 —	3.50
Magnesium	lb.	1.75 —	2.10
Mercury	75 lb.	100.00 —	......
Nickel	lb.	.41 —	.45
Iridium	oz.	175.00 —	......
Palladium	oz.	115.00 —	120.00
Platinum	oz.	105.00 —	110.00
Silver	oz.	1.125—	......

The Iron and Steel Market

At this writing it is uncertain whether there will be anything approaching a general strike in the iron and steel industry. The "strike committee" of the unions affiliated with the American Federation of Labor has pursued curious tactics, all suggestive that it has had doubts whether it could produce a strike by calling one and that its best chance to accomplish anything in the direction of establishing conference relations with the iron and steel manufacturers was to play the strike threat to the utmost. Strikes, being a species of mob psychology, are not welcome in the realm of prediction.

Production of steel ingots in August was at the rate of about 39,100,000 tons a year, or a 10 per cent better rate than that of July, and equal to about 80 per cent of capacity, conservatively estimated. One striking feature of the situation is that one could not count up anything like 20 per cent of idle capacity. Either the managements of various works intentionally refrained from pushing for tonnage, which is altogether improbable, or labor indifference prevented plant units from producing their normal tonnages.

PIG IRON PRODUCTION 80 PER CENT OF CAPACITY

From the efficiency standpoint pig iron makes a better showing, as the rate of production in the first half of September was approximately 80 per cent of estimated capacity, and with many furnaces idle, easily sufficient to count up 20 per cent, without including furnaces that are probably unfit. Conditions as to the unfitness of furnaces have changed, however, and it is improbable that there are furnaces equal to one-fourth the furnace capacity now active that can produce without loss in present conditions. A fundamental change has occurred whereby the labor cost per ton has increased much more at some furnaces than at others, due to high wage rates. Before the war there was more or less equalization, furnaces with low investment and high labor employment having some opportunity to compete with furnaces having low labor employment and heavy investment. In many quarters, therefore, there are predictions that with broader demand pig iron prices must advance. That may easily occur. Relative to finished steel products pig iron prices are perhaps too low. It is a statistical fact that finished steel prices stand at a much larger advance, in percentage, over pre-war averages than is the case with pig iron prices.

DEFLATION IN VALUES PROBABLE

Even steel prices are not as high, compared with pre-war averages, as are commodities in general. It is far from certain, moreover, that a general deflation in values is in prospect for the near future. Although European countries have very high exchange rates upon the United States, our foreign commerce is so aligned as to tend to produce or support inflation in this country, our merchandise trade balance being heavily in our favor, although whether this common expression to represent an excess of exports is really appropriate may be questioned. It is not certain that a large excess of exports at this time is really favorable to our economic situation.

For several weeks the steel mills have been rather indisposed to accept orders from other than regular customers. There are exceptions, but this has been the common attitude. On account of the disposition to refuse orders except from regular customers, the demand that has existed has appeared quite insistent and seems to be of larger volume than is really the case. As a matter of fact jobbers and manufacturing consumers are fairly well covered by contract to the end of the year.

Construction work involving the employment of steel shows a distinctly lagging tendency. New projects are not being undertaken at this time in expected volume. Investors evince a decided tendency to hesitate in the matter of engaging in large undertakings, and the common view is that the hesitancy is due to uncertainties as to the labor cost of construction work involving a long period for its completion, as well as uncertainty as to the time when the work would be completed and would begin to yield returns. For several months following the armistice the common appraisal was that investors would not take hold until the cost of construction material should come down. That is hardly the theory now, since it is generally admitted that there will be no large declines in the near future, but labor costs are on an average quite as important as material costs.

In view of the employment of steel in construction work being well below the normal for active times, and in view of the fact that scarcely any steel is passing to the railroads, the employment of the steel industry, running as it is at about 80 per cent of capacity, is remarkably large. Exports are absorbing only about 20 per cent of the current output, so that the current everyday consumption of steel in domestic trade is really very large.

The Chemical Market

New York, September 10, 1919.

The past two weeks have brought forth a new interest in heavy chemicals in the nature of price inquiries by consumers looking to the fall buying of supplies, with an equally pressing inquiry for deliveries over 1920. Following these inquiries fair sized contracts have been signed covering delivery during the coming year. But this tendency to contract is not confined to heavy chemicals alone. An appreciable volume of business on the leading coal tar intermediates has been contracted for next year. Slashing of prices on many of the vegetable oils, heavy buying of crude rubber by leading tire manufacturers, as well as by dealers last week, with a very dull market on both waxes and naval stores sum up the latest developments.

HEAVY CHEMICALS

Deliveries on existing contracts make up the bulk of present activity in industrial chemicals. Manufacturers are so busy that ten days is the best delivery possible on new orders. Stocks in second hands, too, appear to be less plentiful.

All manufacturers are behind in the production of *sodium bichromate* and do not expect to be caught up until January 1. Their quotations are 15-16c. per lb., sales being made only to old customers. At the last writing, when demand was less active, 14c was the minimum offered by dealers, but at present they are quoting firmly at 14½-15c. The demand is not only foreign, but emanates from the tanners as well.

Bleaching powder (calcium hypochlorite) is one of the products for which contracts have been signed, Buenos Aires being a heavy buyer in the foreign field. The price has been raised to $2.25 per cwt. by some dealers, others announcing no change.

Caustic soda (sodium hydroxide) is active with England offering some lively competition. The price on contract for 1920 is given as $2.82 per cwt., for 60 per cent, f.o.b. works.

Among the chemicals on which the shortage is especially felt are *sodium sulphide, muriatic (hydrochloric) acid, Glauber's salt, soda ash, potassium prussiate, yellow, and glacial acetic acid.* But despite this condition there have been no alterations in price. One large producer who is unable to accept new business in muriatic acid, asserts that if he were in a position to spare any of his output it could be readily marketed at $1.75 per cwt. in tank cars, as compared with the previous maximum figure of $1.50. The scarcity of *potassium, prussiate, yellow,* is readily accounted for by the fact that manufacturers, finding its production unremunerative, have ceased to make it until the price attains a stable basis.

During the past week *formaldehyde* was moved up by several dealers to 22½c. per lb. from 19-21c. Probably the lowest figure at which it can be bought is 20½c. Back of the advance is the paucity of stocks and the sold-up condition of manufacturers as well as the firm position of wood alcohol.

Ostensibly with the object of reducing competition in second hands, domestic manufacturers of *tartaric acid* have announced a reduction of approximately 7c per lb., thus establishing the market for crystals and powdered at 79½c. This sharp cut was primarily made possible because of the improvement in the raw material situation.

On Sept. 2 a new schedule of prices for refined sulphur was announced, according to which sulphur flowers is quoted at $3.10 per cwt. in carlots and sulphur, roll, at $2.95.

Aluminum sulphate and *salt cake* (*sodium sulphate*) conclude the list of particularly active chemicals. With paper mills running to capacity, they are pressing for shipments of the former. Salt cake is well sold up for domestic use, while inquiries are coming from Norway, Sweden, Finland and Canada. But owing to the lack of an international medium of exchange between Scandinavia and United States, England is in a better position to handle this demand, while American producers must underquote England to place orders in Canada.

OILS

The present dullness and sharp cut in prices of vegetable oils can be attributed to three facts: the Government movement to reduce prices, the adverse exchange situation and the failure of European demand. The stoppage of buying from Europe is, of course, almost entirely due to exchange, for fats and oils are needed there as urgently as ever.

Dealers believe that the present condition is merely transient and that prices will begin to creep back, especially when domestic consumers realize that stocks are not large. The majority of oils are selling on an average of at least a cent under last market quotations. The weak condition of the local linseed oil market is evinced by a drop of 10c on September oil, to $2.12 per gal. for raw oil in carlots. Some, however, hold to the old level of $2.22 for spot delivery. October-November delivery is held at $1.98 per gal., December-January at $1.93.

Fish oils are sharing in the downward trend, winter pressed Menhaden now being quoted at $1.32 per gal., a decrease of 3c.

COAL TAR PRODUCTS

Reflecting the recent boom and heavy trading in coal tar intermediates, as well as the augmenting price of raw materials, several price advances are announced. Aniline oil still retains the spotlight of interest. If it was scarce two weeks ago its present status can easily be inferred from the fact that the output of a leading producer is sold from thirty to forty-five days in advance. Whereas a fortnight ago it could be bought at 26c. per lb. little is now obtainable at 30c., manufacturers' prices ranging anywhere from 30-33c.

Along with aniline oil, aniline salt is a scarce item. Although at this writing no advance in price has been made, if demand continues with the present impetus, an increase is likely.

Both salol and salicylic acid have increased in market value by 5c per lb. which fixes the inside figure of the former at 85c and that of the latter at 45c.

Along with the advances in prices is not to be overlooked the encouraging tendency to contract. As a result a fair volume of future business has been closed for aniline oil, beta-naphthol and dimethylaniline, which products, excepting beta-naphthol, are being bought in quantities by Japan and Mexico.

Varying from the general tendency in the coal tar field, competition has brought benzoic acid to 90c per lb. from the previous quotation of $1.00-$1.10.

Now that the sale of Government phenol has been settled, with the Monsanto Chemical Co. acting as the sole selling agent, stocks are being offered at 12-15c per lb. works according to quantity and quality, and subject to certain restrictions. As yet sales cannot be made for export although there is a good demand.

CRUDE RUBBER

Initiating a departure from the continued tranquility in the crude rubber market, plantation grades developed unusual strength last week, all grades being advanced approximately 5c. per lb. Some large orders for October-December and January-June delivery were placed by leading tire manufacturers, who have been holding out of the market. Dealers kept up their end of the activity by purchasing heavily.

Although buying has slowed down perceptibly during the present week, firm foreign markets taken in conjunction with the fact that futures are still quoted above spot (a reversal of normal conditions) presage a firm market with higher prices.

NAVAL STORES

The demand for pine oil, which is at present said to be larger than can be supplied, is not to be taken as an indication of the state of affairs among naval stores. Last week when some activity was in evidence spirits of turpentine suddenly jumped to $1.91 per gal. It has rapidly declined until the present finds it at $1.63. This instability of turpentine has led to the substitution, wherever possible, of the lower priced pine oil. Pine oil, steam distilled, holds at $1.05 per gal.

Chicago, September 10, 1919.

Settled prices and a rather quiet market are the rule in all lines in the Chicago district. Buying continues sufficiently active to sustain prices at existing levels, which in many instances seem high, but is apparently confined to current needs, no one caring to take a chance and lay in surplus stock at prevailing costs. Export business remains negligible, and will probably remain so while foreign exchange rates are so unfavorable.

Heavy Chemicals: Quotations made months ago, viz: Caustic soda, solid, 3¼c. granulated, 4c.; soda ash, 2c., and bleaching powder (calcium hypochlorite), 2c., still hold good with demand steady and supply ample. Short supplies keep prices of red and yellow potassium prussiate and sodium bichromate up to the high points reached six weeks ago. With the exception of nitric, the acids show no change. 60 deg and 66 deg. sulphuric acid are quoted at $12 and $18 respectively, with fair demand for the lower grade. 18 deg. muriatic stands at $22, but nitric, under weak demand, has fallen off to 9c. for spot delivery. Some export business has been handled on methyl alcohol but quotation stands at about $1.25.

Coal Tar Products: The items in this line show undoubted strength. Toluol and benzol at 26c. and 25c. respectively are firmly held and aniline oil in drums advanced 3c. last week, now being quoted at 29c., with spot stocks exhausted and none offered for future delivery before November. Aniline salts have shared in this advance and now are 35c. for immediate delivery. Heavy demand for these commodities from local industries has created a shortage which it will apparently take some time to overcome.

Vegetable Oils: Over-inflation of prices some weeks is evidenced by the continued slump at present. Even linseed oil, under good and wide-spread demand, has declined five cents, $2.13 being asked for large lots, $2.37 for less than five barrels. Current quotations are: corn oil, 21c.; soya bean oil, 17c.; cocoanut oil, 21c., and cottonseedp oil, 30c.

Flotation Oils, Naval Stores: A slight reaction has occurred, all grades of rosin being, at present, off about 50c. compared with thirty days ago. Today's quotation on W. W. grade is $24 and on F grade, $21. Turpentine is obtainable in limited quantities at $1.73, having recently had a decline of 15c. followed by a quick recovery. Prices on distilled pine oil and pine tar oil show but one or two cents decline.

That pine tar products should have weakened at all is rather surprising, but is accounted for by the fact that many small producers of crude, tempted by prevailing high prices, have placed their entire stocks on the market. If this explanation is correct, some further slight decreases may be anticipated, but are almost certain to be followed by a market as strong, or even stronger than that of a few weeks ago. It is a fact that production has not equaled the season's demand, high prices being, therefore, inevitable.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, SEPT. 10, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.55 – $0.60
Acetone	lb.	$0.13½ – $0.14	.15 – .15½
Acid, acetic, 28 per cent	cwt.	2.50 – 3.00	3.00 – 3.25
Acetic, 56 per cent	cwt.	5.00 – 5.50	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00 – 12.50	12.90 – 13.50
Boric, crystals	lb.	.13 – .13½	.13½ – .14
Boric, powder	lb.	.13 – .13½	.13½ – .14
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	1.50 – 1.75	2.00 – 2.50
Hydrofluoric, 52 deg.	lb.	.10 –	.11 –
Lactic, 44 per cent. tech	lb.	.11 – .14	.12 – .16
Lactic, 22 per cent. tech	lb.	.05 – .06	.05½ – .07
Molybdic, C. P	lb.	–	4.50 – 5.50
Nitric, 40 deg.	lb.	.06 – .06½	.07 – .08½
Nitric, 42 deg.	lb.	.07 – .07½	.08 –
Oxalic, crystals	lb.	.23 – .25	.25 – .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 –	.10 – .14
Picric	lb.	.30 – .40	.50 –
Pyrogallic, resublimed	lb.	–	2.30 – 2.45
Sulphuric, 60 deg., tank cars	ton	12.00 – 16.00	–
Sulphuric, 60 deg., drums	ton	17.00 –	22.00 –
Sulphuric, 60 deg., carboys	ton	20.00 –	25.00 –
Sulphuric, 66 deg., tank cars	ton	17.00 – 18.00	22.00 – 23.00
Sulphuric, 66 deg., drums	ton	20.00 – 21.00	25.00 – 26.00
Sulphuric, 66 deg., carboys	ton	25.00 –	30.00 – 40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 –	27.00 –
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 –	32.00 –
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 –	35.00 –
Tannic, U. S. P	lb.	–	1.30 – 1.45
Tannic (tech.)	lb.	–	.42 – .55
Tartaric, crystals	lb.	–	.84 – .86
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl	gal.	4.75 –	4.90 –
Alcohol, Methyl	gal.	1.30 –	1.33 – 1.38
Alcohol, denatured, 188 proof	gal.	.52 –	.54 – .55
Alcohol, denatured, 190 proof	gal.	.46 – .48	.50 – .51
Alum, ammonia lump	lb.	.03½ – .04½	.04½ – .04½
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03½ – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06½ –	.07 – .08
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	–	.30 – .35
Ammonium carbonate, powder	lb.	.13 – .13½	.14 – .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½ – .13	.13½ – .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 – .12½	.13 – .13½
Ammonium nitrate	lb.	.10 –	.11 – .12
Ammonium sulphate	lb.	.05 –	.06 –
Amyl acetate	gal.	–	3.75 – 4.00
Arsenic, oxide, lumps (white arsenic)	lb.	–	.09 – .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	–	–
Barium chloride	ton	75.00 – 80.00	85.00 – 87.50
Barium dioxide (peroxide)	lb.	.22 –	.24 –
Barium nitrate	lb.	.10 – .10½	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.02½ – .03	.03½ – .04
Bleaching powder (see calcium hypochlorite)		–	–
Blue Vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	–	.65 – .75
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	–	.04 – .05
Calcium chloride, fused, lump	ton	19.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01½	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	1.75 – 1.90	2.00 – 2.50
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 –
Calcium sulphate, precipitated	lb.	–	.09 – .09½
Carbon bisulphide	lb.	.05½ –	.06 –
Carbon tetrachloride, drums	lb.	.10 – .11	.12 – .14
Carbonyl chloride (phosgene)	lb.	–	.75 –
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.08 –
Cobalt oxide	lb.	–	1.60 – 1.65
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	–	.28 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .08½	.09 – .09½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Formaldehyde, 40 per cent	lb.	–	.20 – .22½
Glauber's salt (see sodium sulphate)		–	–
Glycerine	lb.	–	.19 – .21
Iodine, resublimed	lb.	–	4.50 –
Iron oxide, red	lb.	–	.03 – .20
Iron sulphate, (copperas)	cwt.	1.00 –	1.20 – 1.50
Lead acetate, normal	lb.		.12½ – .14½
Lead arsenate (paste)	lb.	–	.13 – .17
Lead nitrate, crystals	lb.	–	.85 – .86½
Litharge	lb.	–	.09½ – .10½
Lithium Carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	–	.13 – .14½
Magnesium sulphate, U. S. P	100 lb.	2.00 – 2.63	2.75 – 3.00
Magnesium sulphate, commercial	100 lb.	1.75 –	2.00 – 2.50
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.12 –	.15 – .16
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	–	.60 – .70
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.25 – .28	–
Potassium bitartrate (cream of Tartar)	lb.	–	.55 – .60
Potassium bromide, granular	lb.	–	.49 – .50
Potassium carbonate, U. S. P	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.17 –	.20 –
Potassium chlorate, crystals	lb.	.20 – .24	.25 – .30
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.30 – .32	.35 – .40
Potassium iodide	lb.	–	3.55 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	–	.55 – .65
Potassium prussiate, red	lb.	–	.90 – 1.10
Potassium prussiate, yellow	lb.	–	.50 – .60
Potassium sulphate	ton	225.00 –	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake (sodium sulphate)	ton	17.00 – 18.00	–
Silver cyanide	oz.	–	1.19 –
Silver nitrate	oz.	–	.70½ –
Soda ash, light	100 lb.	1.85 – 1.90	2.00 –
Soda ash, dense	100 lb.	2.25 –	2.50 –
Sodium acetate	lb.	.05½ – .06½	.07 – .08
Sodium bicarbonate	100 lb.	2.35 –	2.75 – 3.00
Sodium bichromate	lb.	.14½ –	.15 – .16
Sodium bisulphate (nitre cake)	ton	3.00 – 8.00	10.00 –
Sodium bisulphite	cwt.	1.80 – 1.90	2.00 – 2.10
Sodium borate (borax)	lb.	.07½ –	.08 – .08½
Sodium carbonate (sal soda)	100 lb.	1.35 – 1.50	1.50 – 1.75
Sodium chlorate	lb.	.15 –	.16 – .18½
Sodium cyanide	lb.	.30 –	.31 – .34
Sodium fluoride	lb.	.13 –	.14 – .15
Sodium hydroxide (caustic soda)	100 lb.	2.75 –	2.90 – 3.50
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.09½ – .10	.10½ – .13
Sodium peroxide, powdered	lb.	–	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04 – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	43 – .45½
Sodium prussiate, yellow	lb.	.17½ – .18½	.19 – .20
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.03½ – .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.05 – 1.35	1.50 – 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	–	.05 – .06
Sodium sulphite, crystals	lb.	.03½ –	.04 –
Strontium nitrate, crystals	lb.	.25 –	– .28
Sulphur chloride	lb.	.05½ –	– .06
Sulphur, crude	ton	22.00 –	–
Sulphur dioxide, liquid, cylinders	lb.	–	.10 – .12
Sulphur (sublimed), flowers	100 lb.	3.10 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 –	3.15 – 3.40
Tin bichloride (stannous)	lb.	.44 –	.46 – .50
Tin oxide	lb.	–	.60 –
Zinc carbonate, precipitate	lb.	–	.20 –
Zinc chloride, gran.	lb.	.12½ –	.13½ – .14
Zinc cyanide	lb.	.49 –	.50 –
Zinc dust	lb.	.09 – .11	.11 – .14
Zinc oxide, dry American	lb.	–	.10 – .13
Zinc sulphate	lb.	.03½ – .03½	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.35	—	.50
Aniline oil, drums extra	lb.	.28½	—	.33
Aniline salts	lb.	.28	—	.33
Anthracine, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.00	—	1.15
Benzidine, base	lb.	1.00	—	1.25
Benzidine, sulphate	lb.	1.00	—	1.15
Benzoic acid, U. S. P	lb.	.90	—	1.10
Benzoate of soda, U. S. P	lb.	.85	—	1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.25	—	.29
Benzol, 90%, in drums (100 lb.)	gal.	.24	—	.28
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	3.75	—	4.50
Beta naphthol, sublimed	lb.	.75	—	.80
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85	—	.90
Cresylic acid, 95-97%, dark, in drums	gal.	.80	—	.85
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.40	—	2.25
Dimethylaniline	lb.	.55	—	.60
Dinitrobenzol	lb.	.26	—	.37
Dinitroclorbenzol	lb.	.25	—	.30
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.33	—	.36
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.65
Diphenylamine	lb.	.58	—	.75
H-acid	lb.	1.60	—	1.75
Metaphenylenediamine	lb.	1.15	—	1.80
Monochlorbenzol	lb.	.12	—	.15
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.06½	—	.07½
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	.75	—	1.25
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.35	—	.45
Nitro-toluol	lb.	.17	—	.20
Ortho-amidophenol	lb.	4.25	—	.....
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.90	—	1.25
Ortho-nitro-toluol	lb.	.27	—	.40
Ortho-toluidine	lb.	.30	—	.45
Para-amidophenol, base	lb.	2.60	—	3.50
Para-amidophenol, HCl	lb.	2.75	—	3.25
Para-dichlor-benzol	lb.	.15	—	.18
Paranitraniline	lb.	.95	—	1.10
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.50	—	4.00
Paratoluidine	lb.	1.50	—	2.50
Phthalic anhydride	lb.	1.75	—	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.15
Pyridin	gal.	2.50	—	...
Resorcin, technical	lb.	3.50	—	3.75
Resorcin, pure	lb.	6.50	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.35	—	.40
Salicylic acid, U. S. P	lb.	.45	—	.48
Salol	lb.	.85	—	.95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.20	—	.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.16	[illegible]	[illegible]
Sulphanilic acid, crude	lb.	.25	—	.30

Tolidine	lb.	$1.70	—	$2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.26	—	.....
Toluol, in drums	gal.	.30	—	.....
Xylidine, drums, 100 gal	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal	gal.	.23	—	.27
Xylol, commercial, in tank cars	gal.	.22	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.41	—	$0.45
Beexwax, refined, yellow	lb.	.48	—	.49
Beeswax, white pure	lb.	.65	—	.68
Carnauba, No. 1	lb.	.86	—	.88
Carnauba, No. 2, regular	lb.	.65	—	.80
Carnauba, No. 3, North Country	lb.	.55	—	.56
Japan	lb.	.18½	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	.....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.06	—	.06½
Paraffine waxes, refined, 118-120 m.p.	lb.	.07¾	—	.08
Paraffine waxes, refined, 128-130 m.p.	lb.	.08¾	—	.09
Paraffine waxes, refined, 133-135 m.p.	lb.	.10½	—	.11
Paraffine waxes, refined, 135-137 m.p.	lb.	.12	—	.13
Stearic acid, single pressed	lb.	.23	—	.26
Stearic acid, double pressed	lb.	.27	—	.28
Stearic acid, triple pressed	lb.	.30	—	.33

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.05
Pine oil, pure, dest. dist.	gal.	.85
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.34
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.85
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.30
Pinewood creosote, ref.	gal.	.48

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$16.80	—	$18.25
Rosin E-I	280 lb.	18.50	—	20.75
Rosin K-N	280 lb.	22.00	—	24.00
Rosin W. G.-W. W.	280 lb.	24.50	—	25.25
Wood rosin, bbl.	280 lb.	17.00	—	18.25
Spirits of turpentine	gal.	1.67	—	1.73
Wood turpentine, steam dist.	gal.	1.63	—	.....
Wood turpentine, dest. dist.	gal.	1.50	—	.....
Pine tar pitch, bbl.	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	12.75	—	13.50
Retort tar, bbl.	280 lb.	13.75	—	14.50
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.95	—	1.07
Rosin oil, fourth run	gal.	1.05	—	1.10

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.55½	—	$0.56
Upriver coarse	lb.	.32½	—	.33
Upriver caucho ball	lb.	.32½	—	.....
Plantation—First latex crepe	lb.	.50	—	.50½
Ribbed smoked sheets	lb.	.49	—	.....
Brown crepe, thin, clean	lb.	.41½	—	.45
Amber crepe No. 1	lb.	.43½	—	.47

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.19
Castor oil, AA, in bbls.	lb.	.21	—	.22
China wood oil, in bbls.	lb.	.21	—	.24
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18	—	.18½
Cocoanut oil, Cochin grade, in bbls.	lb.	.19½	—	.21
Corn oil, crude, in bbls.	lb.	.20	—	.23
Cottonseed oil, crude (f.o.b. mill)	lb.	.18	—	.20
Cottonseed oil, summer yellow	lb.	.25	—	.27
Cottonseed oil, winter yellow	lb.	.26½	—	.28
Linseed oil, raw, car lots	gal.	2.05	—	2.22
Linseed oil, raw, tank cars	gal.	2.10	—	2.19
Linseed oil, boiled, car lots	gal.	2.07	—	2.20
Olive oil, commercial	gal.	2.30	—	2.50
Palm, Lagos	lb.	.17	—	.18
Palm, bright red	lb.	.16½	—	.17
Palm, Niger	lb.	.16	—	.17
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.22	—	.24
Peanut oil, refined, in bbls.	lb.	.27½	—	.28
Rapeseed oil, refined in bbls.	gal.	1.50	—	1.60
Rapeseed oil, blown, in bbls.	gal.	1.57	—	1.70
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.18	—	.18½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.14½	—	.15

FISH

Winter pressed Menhaden	gal.	$1.28	—	$1.32
Yellow bleached Menhaden	gal.	1.30	—	1.35
White bleached Menhaden	gal.	1.32	—	1.36
Blown Menhaden	gal.	1.38	—	.....

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00	—	$36.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	35.00	—	47.50
Casein	lb.	.16	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	$ .04	—	$ .05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	11.50	—	16.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	$30.00	—	$35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	30.00	—	40.00
Fuller's earth, imported, powdered	ton	.....	—	.....
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	1.20	—	.....
Shellac, D. C.	lb.	.....	—	.....
Shellac, V. S. O.	lb.	.....	—	.....
Shellac, Diamond I.	lb.	.....	—	.....
Shellac, orange, fine	lb.	.....	—	.....
Shellac, orange, superfine	lb.	1.35	—	.....
Shellac, A.C. garnet	lb.	.....	—	.....
Shellac, bleached, bone dry	lb.	1.40	—	.....
Shellac, bleached, fresh ground	lb.	1.10	—	.....
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	55.00	—	60.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	net ton	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.30	—	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70	—	.....
Ferro-manganese, 70-80% Mn.	gross ton	105.00	—	115.00
Spiegeleisen, 16-20% Mn.	gross ton	35.00	—	36.00
Ferro-molydenum, per lb. of Mo	lb.	2.50	—	3.00
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, $C_2.O_3$	unit	$0.60	—	$0.80
Chrome ore, 48% and over	unit	.90	—	1.00
Coke, foundry, f.o.b. ovens	net ton	5.50	—	6.00
Coke, furnace, f.o.b. ovens	net ton	4.00	—	5.00
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	—	.....
Fluorspar, gravel, f.o.b. mines	net ton	20.00	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	.....	—	.....
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.13	—	.....
Pyrites, foreign, fine	unit	.13	—	.....
Pyrites, domestic, fine	unit	.14	—	.17½
Ilmenite, 52% TiO_2, f.o.b. N. Y.	net ton	40.00	—	.....
Rutile, 95% TiO_2, f.o.b. N. Y.	net ton	200.00	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free, f.o.b. N. Y.	net ton	135.00	—	.....
Monazite, per unit of ThO_2, f.o.b. N. Y.	unit	42.00	—	.....

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container 300	bbl.	2.65
Common brick, at dock	M.	15.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	55.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	43.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	60.00-70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	2.15
Linseed oil, 5 gal. cans	gal.	2.30
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

CANON—The Kay Copper Co. (Yavapai Co.) is having plans prepared for the construction of a 100-ton concentration and flotation mill, 29 miles north of Peoria Station along the Santa Fe Ry.

MIAMI—The Miami Mining & Milling Co., Gila Co., recently purchased the old mill of the Arizona Butte Corp. and will improve same for its own use.

NOGALES—The Bachman Merrit Co., Santa Cruz Co., will erect a concentration mill to handle vanadium ores from Tres de Mayo property, 12 miles east of here.

PHOENIX—The Arizona Egyptian Cotton Co., 5th and Lincoln Sts. will erect a cottonseed oil refinery to have capacity of 10,000 gal. per day. H. B. Atha, manager.

STODDARD—The Copper Queen Gold Mining Co. has awarded the contract for the erection of a 100-ton flotation plant, to Kennard & Bierce, Higsworth St., Los Angeles, Cal. Estimated cost, $65,000.

TUCSON—The Paymaster-Silver Lead Co. will build a concentration mill, 100-ton capacity, at its mine at Olive Camp, 24 miles south of here. W. F. Hogan, superintendent.

WALKER — The Sheldon Mining Co., Yavapai Co., is planning extensive development work under the direction of Mark Bradley. A new compressor and other equipment will be installed.

California

GLENDALE—The city has engaged Olmsted & Gillelen, engineers, 1112 Hollingsworth Bldg., Los Angeles, to make surveys and submit reports and estimates for sewerage system and disposal works. Estimated cost, $400,000. J. C. Sherer, city clerk.

TORRANCE—The Western Glass Products Co., 707 Hibernian Bldg., Los Angeles, will build a group of buildings on a 10-acre site recently purchased here. A. La-Course, Collingswood, N. J., engineer.

Connecticut

EAST BERLIN—The Connecticut Metal & Chemical Co., Grove Hill St., New Britain, has awarded the contract for the construction of a 1-story factory addition, to J. H. Grozier Co., 756 Main St., Hartford. Estimated cost, $25,000.

NEW HAVEN—The Atlantic Refining Co., 508 Turks Head Bldg., Providence, R. I., has awarded the contract for the construction of a 1-story, 26 x 26-ft. gas service station on Dixwell Ave. and Goffe St., to the Metzger & Fisher Co.. Otis Bldg., Philadelphia, Pa. Estimated cost, $25,000.

WEST HAVEN—The Connecticut Fat Rendering & Fertilizer Co., Front Ave., has awarded the contract for the construction of a rendering plant, to Westcott & Mapes, Inc.. 207 Orange St., New Haven. Estimated cost, $25,000.

Illinois

CHICAGO—H. G. Fischer & Co., 2341 Wakansia Ave.. has awarded the contract for the construction of a 3-story, 60 x 110-ft. X-ray machine factory at 2339 Wakansia Ave., to R. L. Brockob, 5448 Flournoy St. Estimated cost, $70,000.

CHICAGO—G. C. Nimmoms, architect, 122 South Michigan Ave., is receiving bids for the construction of a 5-story, 125 x 127-ft. addition to wall paper factory of Sears, Roebuck & Co., Harvard and Homan Aves. Estimated cost, $225,000.

EAST WOODRIVER (Woodriver P. O.)—The International Shoe Co., 15th and Washington Aves., St. Louis, Mo., has awarded the contract for the construction of a 4-story, 130 x 600-ft. tannery, to the James Black Masonry & Contracting Co., Wright Bldg., St. Louis. Estimated cost, $800,000.

QUINCY—Frank H. Clark, of the National Oil & Refining Co., and others, plan to construct a new oil refinery, here. Estimated cost, $100,000.

Kansas

BELLE PLAIN—The city will soon award the contract for the construction of 6½ miles of sewers, disposal plant, etc. W. B. Rollins & Co., Railway Exchange Bldg., Kansas City, Mo., engineer.

Maryland

CURTIS BAY (Baltimore P. O.)—The U. S. Industrial Alcohol Co. has awarded the contract for the construction of a 2-story addition to its alcohol plant, here, to G. A. Fuller Co., 410 American Bldg. Estimated cost, $300,000.

ST. MICHAELS—The Board of Commissioners has had plans prepared for a sewage disposal plant, by L. J. Houston, engineer, Fredericksburg, Va. Estimated cost, $35,000. Address H. C. Lieb, president.

Massachusetts

WORCESTER — The Worcester Paper Box Co., 68 High St., plans to construct a 4-story, 40 x 110-ft. factory on Houchin Ave. by day labor. Estimated cost, $80,000. S. H. Pitcher Co., 44 Front St., engineer.

Michigan

DETROIT—The National Oxygen Co., 176 Oakland Ave., is having plans prepared for the construction of a 1-story, 40 x 122-ft. oxygen factory. Estimated cost, $10,000. Brown & Preston, 406 Empire Bldg., architects.

DETROIT—The Monarch Foundry Co., Greenwood Ave. and Grand Trunk Ry., is having plans prepared for the construction of a 1-story, 100 x 200-ft. gray iron foundry on Herrick St. and Vernor Avenue. H. M. Lane Co., Owen Bldg., engineer.

MANISTIQUE—Rome G. Brown, Metropolitan Life Bldg., Minneapolis, Minn., has awarded the contract for the construction of several reinforced-concrete and steel paper mill buildings, to Siems, Helmers & Schaffner, foot of Market St., St. Paul, Minn., Estimated cost, $250,000.

Minnesota

FOLEY—The village will soon award the contract for the construction of a sewerage system to include a disposal plant. Estimated cost, $13,400. Henry Bettendorf, clerk.

Missouri

ST. LOUIS — The Lowell Bleachery Co., 7718 Polk St., has awarded the contract for the construction of a 3-story, 103 x 105-ft. addition to its plant, to the Sutherland Building & Construction Co., 915 Olive St. Estimated cost, $50,000.

ST. LOUIS—The Scullin Co., 6700 Manchester Rd., will soon reecive bids for the construction of a 2-story steel rolling mill at 1835 Knox St. Estimated cost, $30,000.

ST. LOUIS—The St. Louis Brass Manufacturing Co., Washington and Jefferson Aves., is having plans prepared for the construction of a 6-story, 175 x 300-ft. brass manufacturing plant on Washington Ave. Estimated cost, $500,000. E. S. Guth, president.

ST. LOUIS—The St. Louis Independent Packing Co., 3815 Chouteau Ave., has awarded the contract for the construction of a 4-story, 100 x 150-ft. by-product manufacturing plant on Vandeventer and Chouteau Aves., to A. H. Haeseler B. & C. Co., Wainwright Bldg. Estimated cost, $55,000. The company is in the market for pulverizers and other equipment.

Montana

BUTTE—The State Board of Examiners, Helena, will soon award the contract for the construction of a 2-story, 75 x 125-ft. metallurgical building, for the State School of Mines here. Estimated cost, $200,000. Floyd Hamill, 409 Lewisohn Bldg., architect. Noted May 15.

SHELBY—The city has awarded the contract for the construction of a sewage disposal plant, to the Two Miracle Concrete Co., 437 Ford Bldg., Great Falls, at $10,450.

Nebraska

BROKEN BOW—F. M. Skillman, city clerk, will receive bids until Sept. 23 for the construction of a sewerage system, including disposal plant and septic tanks. Estimated cost, $105,000. Grant, Fulton & Letton, 505 Bankers Life Bldg., Lincoln, engineers.

GIBBON—The Gibbon Roller Mill Co. has awarded the contract for the construction of a 3-story, 32 x 105-ft. mill, to the Schrack Construction & Engineering Co., 412 American Bank Bldg., Kansas City, Mo. Estimated cost, $55,000.

OMAHA—John Latener & Sons, 632 Bee Bldg., will receive bids Sept. 20 for the construction of a 6-story, 106 x 120-ft. hospital on 26th St. and Dewey Ave., to include filters and a water softener, etc., for the Lister Hospital, 14th St. and Capital Ave. Dr. E. C. Henry, in charge. Total estimated cost, $300,000.

New Jersey

HACKENSACK—The Hackensack Improvement Commission received bids for the construction of a sewage disposal plant, from Hauser & McIsaac, 18 East 41st St., $774,402; Simpson & Brown, 90 West St., $974,176, both contractors of New York City.

NEWARK—The Atlantic Smelting & Refining Co., Ave. R, has awarded the contract for the erection of plant, to Linde & Griffith, foot 4th Ave. Estimated cost, $100,000.

NEWARK—The Cocoanut Oil Co. has awarded the contract for the construction of a 3-story factory, to J. Lowery, Jr., 108 West 40th St., New York City.. Estimated cost, $150,000. Timmis & Chapan, 315 5th Ave., New York City, architects.

NEWARK—The Presto-O-Lite Co., 786 Frelinghuysen Ave., has awarded the contract for the construction of 8 buildings, the largest measuring 60 x 400 ft. and the smallest 30 x 40 ft., for the manufacture of storage batteries for automobiles, oxy-acetylene welding apparatus, etc., to James Mitchell, Inc., 76 Montgomery St., Jersey City.

New Mexico

HANOVER—The Republic Mining & Milling Co. plans to construct a steam turbo generator power plant, ball mill and flotation plant at its zinc mine here and is in the market for hoist, electrical equipment, crushers, flotation machines, etc. Estimated cost, $100,000. O. Wiser, manager.

LORDSBURG—The Bonney Consolidated Copper Co., Grant Co., plans to construct a complete concentration and flotation mill to have a daily capacity of 100 tons. The company is in the market for compressors, etc. J. P. Portens, superintendent.

SANTA RITA—The Grant County Copper Co. plans to install a flotation plant, etc., in its zinc mine here and is in the market for crushers, rollers, tables and vanners. Estimated cost, $20,000. H. B. Link, superintendent.

New York

ALBANY—The Albany Perforated Wrapping Paper Co., 1271 Broadway, has awarded the contract for the construction of a brick addition to its factory, to William G. Sheehan Construction Co., 28-30 De Witt St. Estimated cost, $18,000.

NIAGARA FALLS—The Carborundum Co., Buffalo Ave and 14th St., plans to build a 3-story 99 x 224-ft. carborundum plant on Buffalo Ave. Estimated cost, $150,000. L. J. Call, chief engineer.

ROCHESTER—The Board of Contract & Supply has awarded the contract for the construction of a new sewage disposal plant in the 23rd Ward, to Whitmore, Rauber & Vicinus, 279 South Ave. Estimated cost, $49,927. Noted Feb. 15.

North Carolina

GOLDSBORO—The Seminole Phosphate Co. has awarded the contract for the construction of a 1-story fertilizer factory, to D. J. Rose, Rocky Mount. Estimated cost, $22,000.

North Dakota

MINOT—The city plans an election Sept. 29 to vote on $280,000 bonds for the construction of an Imhoff tank and sewer mains. E. J. Thomas, Minot, engineer.

Ohio

ASHLAND—The Faultless Rubber Co. has awarded the contract for the construction of a 3-story, 83 x 168-ft. factory addition here, to J. R. Gloyd Co., 1816 East 33rd St., Cleveland. Estimated cost, $100,000. Noted Aug. 1.

CLEVELAND—The Enamel Products Co., 341 Eddy Rd., has awarded the contract for the construction of a 2-story, 40 x 180-ft. factory addition, to William Dunbar Co., 8201 Cedar Ave. Estimated cost, $10,000. Noted Sept. 1.

CLEVELAND—The General Bronze & Foundry Co., 4900 Hamilton Ave., plans to construct a 1-story, 100 x 125-ft. factory on East 49th St. Estimated cost, $60,000. Architect not selected.

CLEVELAND—The Glidden Varnish Co., West 110th St. and Berea Rd., has awarded the contract for the construction of a 2-story, 58 x 117 ft. factory addition at 11,410 Berea Rd., to J. R. Gloyd Co., 1816 East 33rd St. Estimated cost, $15,000.

CLEVELAND—The Standard Brass & Foundry Co., 990 East 67th St., has awarded the contract for the construction of a 2-story, 38 x 59-ft. office and shop to August Haase, 9028 St. Claire Ave. Estimated cost, $10,000.

CLEVELAND—The Superior Brick Co., Leader News Bldg., plans to construct a 2-story plant for the manufacture of bricks on Jennings Rd. Estimated cost, $500,000. Architect not selected.

Oklahoma

COLLINSVILLE—The city voted $40,000 bonds for the construction of a water filtration plant. Noted Sept. 1.

Oregon

BAKER—The Ben Harrison Mines Co. plans to enlarge its mining plant in Greenhorn District, also install flotation system and build machinery houses. Estimated cost, $50,000. W. C. Fellows, Baker, manager.

PORTLAND—The Central Waxed Paper Co., 5600 Fillmore St., Chicago, plans to construct a 3-story plant in North Portland. Estimated cost, $100,000. A. Christ, president.

Pennsylvania

LOCK HAVEN—The American Aniline Chemical Co. is making extensive improvements and additions to its plant which was recently operated by the Stanley Aniline Chemical Co. C. H. Dasher, manager.

NEW BRIGHTON—The New Brighton Board of Education is receiving bids for the construction of a 3-story, 90 x 135-ft. and 2-story, 82 x 98-ft. high school on Pierce and East 4th Sts. A chemical laboratory will be installed in same. W. G. Echles, New Castle, architect.

PITTSBURGH—W. W. Lawrence & Co., West Carson St., has awarded the contract for the construction of a paint factory, to E. A. Wehr, Highland Bldg. Estimated cost, $12,500.

Rhode Island

PROVIDENCE—The Revere Rubber Co., 355 Valley St., has awarded the contract for the construction of a 30 x 121-ft. factory addition on Eagle St., to Cruise & Smiley Construction Co., Main St., Pawtucket. Estimated cost, $20,000.

Texas

FORT WORTH—The Ok-In Producing & Refining Co. plans to construct a refinery, having an ultimate capacity of 5,000 bbl. of crude oil per day. Work will be done under supervision of John S. Blair, chief engineer, and J. T. Thompson, superintendent of construction.

Washington

BOSSBURG—The Big Bonanza Mine plans to expend $15,000 in devolopment work and blocking out ore and installing concentrator. Olaus Jeldness, 2029 Second Ave., Spokane, manager.

NESPELEM—The Great Metals Mining & Milling Co. plans to improve its mill and is in the market for a filter press, clearing cells and storage bins. Elmer C. Williamson, manager.

SEATTLE—The Western Wall Board Co. plans to construct a 2-story, 50 x 100-ft. addition to its present plant at 4511 9th Ave., S. Estimated cost, $20,000.

West Virginia

FAIRMONT—The West Virginia Metal Products Co. will soon receive bids for the construction of a 1-story, 280 x 360-ft. factory, J. M. Boyle, 14 Wall St., New York City, engineer.

HUNTINGTON—C. C. Haywood and others, Ironton, Ohio, plan to build a plant for the production of bricks on 16th St. Rd. Estimated cost, $200,000.

HUNTINGTON—The Huntington Tumbler Co. plans to construct a 1-story, 82 x 272-ft. glass manufacturing plant on 15th St. Estimated cost, $100,000. A. Ford Dickey, architect.

HUNTINGTON—The Huntington Brick & Tile Co. plans to construct a 1-story brick plant at Westmoreland, to include elevators; main building 100 x 150 ft., also an 80 x 100-ft. dry kiln and 16 oval top kilns of 50-ft. diameter. Estimated cost, $150,000. T. M. Davidson, engineer.

British Columbia

BURNABY—The Gregory Tire & Rubber Co., 1404 Standard Bank Bldg., Vancouver, plans to build a 1-story, 100 x 240-ft. mill construction factory on Euclid Ave. and Collingwood St., here. Estimated cost, $50,000.

Ontario

BIRCHCLIFFE — Scarboro township plans to construct a waterworks system, to include filters, intake, etc. Estimated cost, $100,000. E. James, 57 Adelaide St., E., Toronto, engineer.

BROCKVILLE—The Consolidated Iron & Steel Corp., Ltd., 20 King St., E., Toronto, plans to construct an iron smelter, here. Estimated cost, $8,000,000.

CAPREOL—The Canadian National Rys., 27 Wellington St., E., Toronto, plans to install a chlorine or ultra violet sterilization system for swimming pool in connection with proposed 3-story, 72 x 120-ft. Y. M. C. A. building which it plans to construct. Total estimated cost, $75,000. A. F. Stewart, 27 Wellington St., E., Toronto, engineer.

TORONTO—H. B. Johnstone & Son, 774 Dundas St., E., will soon receive bids for the construction of a 3-story, 80 x 150-ft. tannery on Cameron Ave. Estimated cost, $130,000. John M. Lyle, Avondale Rd., architect.

Quebec

MONTREAL—The Booth Coulter Copper & Brass Co., 19 Queen St., has awarded the contract for the construction of a 2-story, 25 x 40-ft. factory, to S. Saratinal, 470 Amherst St. Estimated cost, $19,000.

Hawaii

HONOLULU—The Hawaiian Fertilizer Co. is having plans prepared for the construction of a 3-story, 60 x 180-ft. factory. T. Ronneberg, Crocker Bldg., San Francisco, Cal., engineer.

Coming Meetings and Events

The American Ceramic Society will hold a meeting in Chicago, Sept. 24.

The American Electrochemical Society will hold its Fall meeting in Chicago, Sept. 23 to 25 inclusive.

The American Foundrymen's Association will hold its 1919 convention in Philadelphia, Sept. 29 to Oct. 4.

The American Gas Association will hold its annual convention and exhibtion of gas appliances and apparatus at the Hotel Pennsylvania, New York, Oct. 13 to 18.

The American Institute of Mining and Metallurgical Engineers will hold its Fall meeting in Chicago, Ill., Sept. 22 to 27.

The American Peat Society will hold its thirteenth annual meeting at Minneapolis, Minn., Sept. 22 to 24 inclusive.

The American Steel Treaters' Society will hold its first annual convention in Chicago, Ill., Sept. 22 to 27.

The Electric Furnace Association will hold a meeting in Chicago on Monday, Sept. 22.

The Electrical Exposition will be held in Grand Central Palace, New York City, Sept 24 to Oct. 4.

The Fifth National Exposition of Chemical Industries will be held in Chicago, Ill., Sept. 22 to 27 inclusive.

The Institute of Metals Division of the A. I. M. E. will hold its next meeting in Philadelphia, Pa., Sept. 29 to Oct. 4.

The National Safety Council will hold its Eighth Annual Safety Congress in Cleveland, Oct. 1 to 4.

The Technical Association of the Pulp and Paper Industry will hold its Fall meeting in Chicago from Sept. 24 to 27.

Industrial Notes

Capt. Donald M. Liddell announces that on July 21 he again took up his work of chemical engineering, with offices in Rooms 1800-1802, 66 Broadway, New York City, and a laboratory at 961-965 Frelinghuysen Ave., Newark, N. J.

The Wheeler & Engineering Co., Carteret, N. J., elected Mr. J. J. Brown, formerly vice-president and general manager, as president, at its board of directors meeting July 8. Mr. J. J. Brown succeeds Charles W. Wheeler, recently deceased. Mr. H. S. Brown of 50 Congress St., Boston, was elected vice-president.

The Hercules Engineering Corp., of Chicago and New York, announces that Major M. G. Donk has joined its staff. His work is of a special character on the installation of equipment. Dr. J. T. Brewster, who has acted in a consulting capacity with this corporation for the last three years, succeeds Mr. A. H. Alberger as head of the technical and engineering department.

Briggs & Turivas, of Chicago and New York, operators in iron and steel scrap and salvage, have purchased from the Imperial Munitions Board of Canada the entire plant and property of the British Chemical Co., Ltd., located at Trenton, Province of Ontario, Canada. A Canadian corporation under the name of Briggs & Turivas of Canada, Ltd., and capitalized at $1,200,000, has been formed, with main offices in the C. P. R. Bldg. at Toronto, Ontario, and a branch office at Trenton, Ontario. The property consists of 255 acres and fronts the Trenton River, a navigable stream, with Lake Ontario as its source. Three trunk line railroads enter the plant. The British Chemical Company was formed and built during the war at an outlay of approximately $8,000,000. It is completely modern in all respects. The equipment consists principally of two separate and complete sulphuric acid chamber plants, sulphuric acid concentrators, a nitric acid plant, an alcohol rectifying plant, two refrigerating plants, a smokeless powder plant, a complete high pressure fire system, two miles of narrow gage trackage with electric locomotives and trucks, two boiler houses, electrical equipment, warehouses, storage tanks, administration buildings, etc. The plant had a daily capacity of over 100 tons of sulphuric acid, 75 tons of nitric acid, 25 tons of finished smokeless powder and 45 tons of ethyl alcohol. The new owners are as yet undecided as to the extent of the operations of the plant for the future, but it is expected that the powder manufacturing apparatus and equipment, and possibly the nitric acid plant, will be dismantled and disposed of, allowing the sulphuric acid plants to stand, there being a good market in Canada for sulphuric acid for the manufacture of fertilizer, for which the demand in that country is great.

The Fate-Root-Heath Co. announces that on July 1, 1919, it succeeded to the business of the J. D. Fate Co. and the Root-Heath Mfg. Co., the consolidation being made to meet the growing demand for Plymouth industrial locomotives, clay-working machinery and other Plymouth products. The officers of the new company are: President, J. A. Root; vice-president and general manager, C. E. Heath; second vice-president, W. F. Root; secretary, P. H. Root; treasurer, H. R. Sykes, and sales manager, H. J. Votan.

The Worthington Pump & Machinery Corp., New York, announces its purchase of the plant, patterns, accounts, patents and other assets of the Epping-Carpenter Pump Co. located at 10 43rd St., Pittsburgh, Pa., which will be known as the "Epping-Carpenter Works" of the Worthington Pump & Machinery Corp. Orders and contracts now in hand will be completed by the Worthington Pump & Machinery Corp., and all further business will be for its account.

Buckman & Pritchard, Inc., announces that a postoffice has been established at

Mineral City, Fla., and requests that all communications be sent there with the exception of telegrams, which should be sent to Pablo Beach, Fla.

The Bronze Alumina Corp. has removed from Tonawanda, N. Y., to a new shop in Buffalo.

The Electrolytic Oxy-Hydrogen Laboratories, Inc., announces the formation of a sales and manufacturing company under the name of the Electrolabs Company. The Electrolytic Oxy-Hydrogen Laboratories, Inc., will continue in charge of the laboratories and maintain a technical supervision over the work of the new company. The general offices and works of both companies have been moved from Dayton, Ohio, into larger quarters at 2635 Penn Ave., Pittsburgh, Pa., to provide increased facilities for its expanded business. The general sales offices are being continued at 15 William St., New York City, and branch sales offices have been opened in the Morris Bldg., Philadelphia, and the Merchants Exchange Bldg., San Francisco. Mr. I. H. Levin continues in charge of the technical and research work, and Mr. D. J. Tonkonogy in general charge of sales.

The Livingston Refiners Corp. of Tulsa, Okla., has just placed an order for 100 "Pennsylvania" tank cars with the Pennsylvania Tank Car Co. of Sharon, Pa., to be used in the transportation of the corporation's petroleum products.

The Green Engineering Co., East Chicago, Ind., announces the appointment of the firm of Bull & Livensparger as its sales representatives in Chicago and northern Illinois territory. On Aug. 1 they took charge of the Chicago sales office at 14 E. Jackson Blvd. This company also announces the appointment of Mr. E. L. Sullivan as representative in the Pittsburgh district.

Mr. William Lanyon announces that he has sold the plant of the **Robert Lanyon Zinc & Acid Co.**, at Hillsboro, Ill., to the Eagle-Picher Lead Co.

The Blaw-Knox Co., Pittsburgh, Pa., announces the appointment of Mr. L. C. Murray as engineer-salesman in the "Knox" department. This company also announces the opening of an office in the Little Bldg., Boston, Mass., and in the Owen Bldg., Detroit, Mich. Mr. A. W. Ransoms will have charge of the New England office, and Mr. H. J. Desson will be manager of the Michigan district.

The Chicago Pneumatic Tool Co. plans moving its general offices from Chicago to New York, and is erecting an office building at 6-8 East 44th Street, New York City. This company also announces the removal of its Cincinnati office from the Mercantile Library Bldg. to the Walsh Bldg.; the appointment of Mr. J. L. Canby as district manager of sales at Chicago, succeeding Mr. Nelson B. Gatch, who has been transferred to New York as district manager of sales; and the appointment of Mr. Fred Gehbauer as special Navy Yard representative, with headquarters at the Philadelphia office.

The Foundation Co., New York City, announces that at a recent meeting of the board of directors, Franklin Remington was elected chairman of the board, John W. Doty was elected president of the company, and H. J. Deutschbein first vice-president and general manager.

Chas. Butters & Co., Ltd., New York, announces that Mr. Chas. Butters, who has hitherto been acting as managing director, is no longer associated with the company.

The National Association of Purchasing Agents through its standardization committee is endeavoring to bring about the adoption of standard forms for invoices, purchase orders, acknowledgments and notices of shipment. Any one interested in this movement should communicate with the chairman of the committee, Mr. W. L. Chandler, Dodge Sales & Engineering Co., Mishawaka, Ind.

The Electric Furnace Construction Co., Philadelphia, advises the receipt of an order from the Hammond Steel Co., Syracuse, N. Y., for one 3-ton furnace for the manufacture of high-grade tool steels; the installation of a "Greaves-Etchells" furnace in the Hongkong Steel Foundry Co., China; an order from Capt. Teixeira, a member of the Brazilian Military Commission, through Fenwick Freres & Co., New York, for a "Greaves-Etchells" electric furnace; an order received from a new steel castings plant, the Dodge Steel Co., Philadelphia, which installation will be a 3-ton furnace of the latest "Greaves-Etchells" type.

The Cassel Cyanide Co., of Glasgow, will incorporate a subsidiary company in Canada.

New Publications

The Annual Report on the Mineral Production of Canada, During the Calendar Year 1917. Issued by the Canadian Department of Mines, Ottawa.

The Carbonization of Missouri Cannel Coals. By Howard Leroy Dunlap, assisted by Karl Kenneth Kershner and Vivian Xly Smiley. Vol. 5, No. 1, of the technical series issued by the School of Mines and Metallurgy, University of Missouri, Rolla, Mo.

A Reference List of the Electrochemical Industry is the title of a copyrighted pamphlet issued by the American Electrochemical Society, South Bethlehem, Pa. This pamphlet contains a comprehensive list of firms engaged in that industry in the United States and Canada and also gives a list of the products of the industry.

The Sensitiveness of Some Cyanide Reactions. By John B. Ekeley and Icie C. Macy. Published by the Colorado Scientific Society, Denver, June, 1919.

A Contribution to the Hydrology of the San Luis Valley, Colorado. By William P. Headden. Published by the Colorado Scientific Society, June, 1919.

An Investigation of the Stresses in the Transverse Bent for Steel Mill Buildings. By C. S. Sperry. Published by the Colorado Scientific Society, June, 1919.

Employment Management, Employee Representation and Industrial Democracy. A pamphlet issued by the U. S. Department of Labor, Working Conditions Service, which is an address delivered before the National Association of Employment Managers, Cleveland, May 23, 1919. By W. M. Leiserson.

War Trade Board Journal, with official rulings and announcements of the Board and its Bureau, issued by the War Trade Board, June, 1919.

Readjustment and Reconstruction Activities in Foreign Countries is the title of a booklet issued May 1, 1919, by the United States Council of National Defense.

The American Library Association (Library War Service), Washington, D. C., has issued a booklet entitled "One Thousand Technical Books", compiled by Herbert L. Cowing, which aims to fit discharged American soldiers and sailors into useful civilian occupations. The list includes books on engineering, basic subjects, civil engineering, mechanical engineering, electric engineering, building, mining and metallurgy, chemical technology and miscellaneous.

Utilization of Waste Sulphite Liquor is the title of Bull. 66 issued by the Forestry Branch, Department of the Interior, Canada.

New United States Geological Survey Publications: II:30, Stone in 1917, by G. F. Loughlin and A. T. Coons (Mineral Resources, 1917, Part II), published June 20, 1919; II:3, Gems and Precious Stones in 1918, by Waldemar T. Schaller (Mineral Resources, 1918, Part II), published July 16, 1919; II:2, Sand-Lime Brick in 1918, by Jefferson Middleton (Mineral Resources, 1918, Part II), published June 10, 1919; The Farnham Anticline, Carbon County, Utah, by Frank R. Clark; Bull. 711-A, which is a contribution to economic geology, 1919, Part II, published July 3, 1919.

The Federal Board for Vocational Education is issuing a series of Opportunity Monographs for disabled soldiers, sailors and marines. Series No. 29 is on "Drafting" and No. 40 on "Electric Welding."

New War Industries Board Publications: Bull. 45, Price of Mineral Acids, by H. L. Lewenberg; Bull. 46, Prices of Heavy Chemicals, by H. L. Lewenberg; Bull. 47, Prices of Miscellaneous Inorganic Chemicals, by W. B. Meldrum; Bull. 50, Prices of Essential Oils, Flavoring and Perfumery Materials, by W. B. Meldrum; Bull. 54, Prices of Drugs and Pharmaceuticals, by W. Lee Lewis and F. W. Cassebeer; Bull. 55, Prices of Proprietary Preparations, by W. Lee Lewis and F. W. Cassebeer. No. 7. Prices of Chemicals, by F. E. Breithut: No. 53, Prices of Coal Tar Crudes, Intermediates, and Dyes, by Webster N. Jones and F. W. Cassebeer; No 38, Prices of Clay Products, by Homer Hoyt.

New Bureau of Standards Publications: No. 124, Constitution and Microstructure of Silica Brick and Changes Involved Through Repeated Burnings at High Temperatures, by Herbert Insley and A. A. Klein, issued July 11, 1919; No. 334, New Forms of Instruments for Showing the Presence and Amount of Combustible Gas in the Air, by E. R. Weaver and E. E. Weibel, issued June 28, 1919; No. 335, Effect of Rate of Temperature Change on the Transformation in an Alloy Steel, by Howard Scott, issued July 10, 1919.

New Bureau of Mines Publications: Tech. Paper 212, The Determination of Combustible Matter in Silicate and Carbonate Rocks, by A. C. Fieldner, W. A. Selvig and G. B. Taylor; Tech. Paper 216, Vitiation of Garage Air by Automobile Exhaust Gases, by G. A. Burrell and A. W. Gauger; Tech. Paper 220, Burning Steam Sizes of Anthracite, With or Without Admixture of Soft Coal, reprint of Engineering Bull. No. 5, prepared by the United States Fuel Administration in collaboration with the Bureau of Mines; Bull. 176, Recent Developments in the Absorption Process for Recovering Gasoline from Natural Gas, by W. P. Dykema; Bull. 178C, Petroleum Investigations and Production of Helium, advance chapter from Bull. 178. War Work of the Bureau of Mines, by Van H. Manning; War Minerals Investigation Series No. 17. Preparation of Manganese Ore, by W. R. Crane.

Stocks and Bonds

Closing Bid and Asked Quotations Sept. 12, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am.Ag.Ch.	98	100	Mat.Al.Wk.	31	34
do.pf.	...	98	Ten. C. & C.	13	13½
Barrett Co.	126	128	Un. Dyewood	50	...
do.pf.	112	114	do.pf.	96	...
Gen. Chem.	...	180	Va.-Car.Ch.	81½	82¾
do.pf.	101	104	do.pf.	113½	114¾
Int.Ag.Ch.	25	27			
do.pf.	81½	83			

Bonds

	Bid	Ask
Am. Ag. Ch., 1st cv. 5s, '28	94	100
Am. Ag. Ch., cv. db. 5s, '24	101¾	107
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32	83	83¾
Va.-Car. Ch., 1 mtg. 5s, '23	95½	95¾
Va.-Car. Ch., cv.db. 6s, '24	102	103

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co.	90	91	P-A Pet & Tr	121	121¾
Cal. Pet.	53	53½	do. pf.	...	...
do. pf.	85¾	86	Pierce Oil.	21½	21¾
Col. G. & E.	62¾	62¾	Royal Dutch.	97¾	...
Mex. Pet.	207¾	207½	Sinclair O&R.	60	60½
do. pf.	107	112	Texas Co.	265½	267
Ohio Cit. Gas.	53½	53½	Tex. Pac. Ld. Tr.	300	500
do. pf.	...	...	Tidewater Oil	238	245
Ohio Fuel S.	50	50¾			
Okla. P. & R.	10½	10¾			

Bonds

	Bid	Ask
Columbia Gas & Electric, 1 5s, '27	89	89½
Col. G. & El., std. 1 5s, '27	87	89¾
Pan-Am. Pet. & Tr. 1 6s, '19-'27	180	...
Pierce Oil, cv. db. 6s, '24	105¾	105¾
Pierce Oil, cv. 5% Notes, '20	105¾	120
Sin. O. & R. 1 ln. 7s, '20, with stk. war.	...	...
Sin. O. & R. 1 ln. 7s, '20 without stk war.	...	...
Texas Co., db. 6s, '31	102½	102¾
Union Oil of Cal. 1 5s, '31	94½	95
United Fuel Gas 1 mtg. 6s, ser. A., '36	96	98

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F.	39½	40	Pitts. Ste. pf.	89¾	92½
Beth. Steel.	80	85	Rep. Iron & Steel.	91¾	92
do. class B.	91¾	91½	do. pf.	105¾	107
do. pf., 8%.	111¾	114	Sloss Sheff. I. & S.	64	65½
do. pf., 7%.	107	110	do. pf.	87	92
Central Fdry.	27	31	Superior Steel	43	43½
do. pf.	55	59	do. 1 pf.	102	105
Col. F. & I.	45	45½	Trans. & W. Steel.	57	58
do. pf.	...	...	Un. Alloy St.	50½	52
Cruc. Steel.	183½	184	U.S.C.I.P.&F.	31¾	32
do. pf.	103	106	do. pf.	55	56
Great No. Ore	43¾	44	U. S. Steel.	103¾	104
Gulf Sta. Steel	60¾	61	do. pf.	114½	114½
do. 1 pf.	94	98	Va. Coal, I&C	60	65
Lack. Steel.	82¾	83			
Mid.St.&Ord.	51	51¾			
Nova Scotia Steel.	75½	76			

Bonds

	Bid	Ask
Beth. Steel, 1 ext. gtd. S.F. 5s, '26	96	98
Beth. Steel, 1 ln. ref. 5s, Ser. A, '42	88½	92
Beth. Steel, P. M. & I. S. F. 5s, '36	86	86½
Buff & Susq. Iron, 1 S. F. 5s, '32	...	91¾
Buff & Susq. Iron, deb. 5s, '27	90	...
Cent. Found, 1 mtg. S. F. 6s, '21	86	86½
Col. F. & I., gn. S. F. 5s, '43	89½	92
Ill. Steel, db. 4½s, '40	84½	85½
Ind. Steel, 1 mtg. gtd. 5s, '52	...	94½
Lack. Steel, 1 5s, '23	97	98
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	92¾	95
Mid. St. & Ord., clt. cv. S. F., 5s, '36	87¾	87¾
Nat. Tube, 1 mtg. gtd. 5s, '52	94½	...
Rep. I. & S., S. F. mtg., 5s, '40	95	95¾
Tenn. C. & I. R.R. 'gn. 5s, '51	89½	89¾
U. S. Steel, S. F. 5s, 63	99¾	99¾
Va. C., I. & C., 1 5s. '49	84½	85½

Permission to mail this special edition in Cooperstown, N. Y., has been accorded the publisher by the Post Office Department.

CHEMICAL
& METALLURGICAL
ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, October 1, 1919 *Number* 7

Announcement of Weekly Publication

BEGINNING with this issue of CHEMICAL & METALLURGICAL ENGINEERING, the magazine will be published weekly instead of semi-monthly as heretofore. The project has been under consideration for more than a year, and only unusual industrial conditions throughout the world prevented the consummation of the plan at an earlier date. We believe the step is now justified by the situation prevailing in the industries represented in our title. Not only are they more firmly established than ever before in the history of our country, but they are more vital to our eminence as a world power. There is international competition ahead not yet realized, nor will it manifest itself in full measure until the nations of Europe settle down to steady production and strike their gait. It were nothing short of the folly of unpreparedness to await that time before putting our own house in order. Progress is rapid; developments grow apace; the industries are in a state of flux. Prompt and timely presentation of the news, technical and industrial, demands more frequent publication of a magazine that presumes to act as an exponent of chemical and metallurgical engineering in the United States. In this effort to serve new as well as old established industries within their domain, American publishers are not alone. Contemporaries have recently made their appearance in England and Canada; German publishers are again active, and French technical literature is appearing in greater quantity than ever before. The need of disseminating information while it is timely and valuable is felt throughout the world. We are confident, however, that with the co-operation of our readers and contributors we can so serve our industries as to keep them not only abreast of the times but in the van of progress. To this end we have laid our plans, and to its accomplishment we pledge unlimited facilities.

The Path Of Sanity

BLASÉ indeed must be the man who can view with equanimity and unconcern the threatening aspect of the industrial situation in the United States today. With radical agitators defying their more conservative superiors, with labor unrest lowering production at a time when steady and greater production is one of the remedies of our trouble, with inflammatory speech and action prevailing where wise counsel and sober meditation was to have been expected, and with men by the hundred forsaking the paths of reason and sanity to follow after false gods, the need of wise leadership was never greater. A task is set for every patriotic American who cares to see his country escape the catastrophe that has engulfed Europe, particularly Russia and Hungary. We hold it to be the duty of every intelligent citizen to exert his influence for patience and reason, to speak wisely and inculcate sound doctrine among his associates, to discountenance violence, threats and incendiary speech, and to get clearly in his own mind the fundamental elements of the situation.

No man of vision doubts that the world is undergoing a profound change in the social order that means as much for democracy in industrial relations as the war did for democracy in government. The evidences are on every hand and found in the mouths of true leaders of Capital as well as of Labor. But it is a change that is not going to be wrought by force and violence; nor does it need to be, because the truth is appreciated by those who have the power to put it into effect. It may have been necessary for Russia to have her experience in Bolshevism, but, as Mr. HOOVER says, "it is not necessary that we of the United States, now that we have witnessed these results, plunge our own population into these miseries and into a laboratory for experiment in foreign social disease."

It is, however, necessary that we should find the proper remedy, not only for the foreign social disease but for the domestic malaise that now afflicts us and offers a tempting excuse for the agitator. Mr. HOOVER believes that this is "the paramount business of every American today," and that "we shall never remedy justifiable discontent until we eradicate the misery which the ruthlessness of individualism has imposed upon a minority." This is a sufficiently strong statement to please even a radical agitator, but it emanates from an intelligent source and carries conviction that is lacking in the catch phrases of the Reds. Labor today has the sympathetic ear of an intelligent public. The pendulum has been swinging its way for some time past, even to the detriment of Capital, and we have made more than an approach to that equality of opportunity and better distribution of production which is the ideal condition. Undoubtedly both Labor and Capital have much more to learn, and the Community has something to demand of both. In the light of the present situation, what may these things be?

In the first place, Labor must appreciate the fallacy of reaching Elysium through constant reduction of hours of employment and increase in compensation. The demoralized industrial production of Europe, particularly those parts in which the experiments of Communism have been tried, must convince even the ignorant that only disaster can follow such steps. Two years of Bolshevism have plunged the Russian people into deeper physical distress than ever they knew under the Czar; and today, as Mr. HOOVER points out, "the very High Priest of Socialism is vainly endeavoring to save his people from their destruction by summoning back the forces of production." Russia had raw materials and labor in plenty, but in some mysterious way all were to prosper without producing. As a consequence Mr. HOOVER believes that "Socialism as a philosophy of possible human application is bankrupt," having "wrecked itself on the rock of production."

A lesson may be taken by Labor from the new spirit of the German republic. If the cabled news is to be accepted, German labor believes that only in steady and increased production lies their salvation. Nay more, they believe that it is the road to national supremacy. Consequently, we find them demanding not shorter hours, but longer; not restricted production in order that more may be employed, but unlimited production so that the people as a whole may enjoy a higher standard of living and the workers receive a larger return. It may be stated as an accepted fact that the nation which most quickly resumes normal production will occupy the strategic position in world trade, and the sooner Labor realizes this and proceeds accordingly, the better for all of us.

With wider powers and increased authority in industrial affairs, Labor must accept a new responsibility. Its wiser leaders are deprecating the use of the strike, especially among classes of public servants on whom the safety of the community depends, but there are still many agitators who would have policemen, firemen and similar workers enforce their demands with the strike. This is little short of madness, for it is but a step further to involve soldiers and sailors—and then Soviet government. If Labor cannot intuitively perceive the duty and responsibility of public servants to the community, and discountenance the formation of striking unions among them, public approval must inevitably desert the Labor cause. The Governor of Massachusetts is worthy of all commendation for his action in the Boston police strike. More power to his arm, and to all who show his wisdom and courage!

If Labor has lessons of moderation and co-operation to learn, so has Capital. First it must take the initiative in bringing about that co-operation that must exist before either party can prosper in the highest degree. Labor's demands for a share in the profits and in the management of industry are generally recognized as fair, and it is incumbent on intelligent Capital and Management to devise equitable schemes for the consummation of these ideas. As Dr. STEINMETZ once said, "there are several ways—mostly unsuccessful"; but he went on to declare that "Capital is entitled to a fair rate of interest on the money invested and Labor is entitled to a fair rate of wages for the work done. All profits beyond that belong to Capital and Labor. These should be divided as dividends on capital stock, and on labor stock as found by yearly wages. This system is in operation in a number of corporations."

As intimated before, there must be a more equitable distribution of the products of industry, and this means the abolition of profiteering and of the exorbitant profits on capital that once were regarded as perfectly legitimate even though obtained at the expense of fair treatment of the workers. If Labor's right to share in the profits of industry is being recognized, no less is its right to share in the management. Capital must recognize the fact that domination by any one element will not secure maximum production, so essential to the welfare of the Community, but that it will be obtained only by "giving a voice in the administration of production to all sections of the Community concerned in the specific problem."

All these ideas will seem idealistic to the conservative and reactionary, but they are in practical application in enough places and enough forms to know that they are fundamentally right and workable. The Community is demanding more and more that industrial conditions be established that shall relieve it of the periodical hold-up to which it is subjected by strikes and profiteering. We believe the most progressive minds of the day are confident of the future and willing to risk the application of principles of fairness and justice. We believe with LOWELL, who wrote

> New times demand new measures and new men;
> The world advances and in time outgrows
> The laws that in our fathers' day were best;
> And, doubtless, after us some purer scheme
> Will be shaped out by wiser men than we,
> Made wiser by the steady growth of truth.
> The time is ripe, and rotten-ripe, for change;
> Then let it come; I have no dread of what
> Is called for by the instinct of mankind.
> Nor think I that God's world would fall apart
> Because we tear a parchment more or less;
> Truth is eternal, but her effluence,
> With endless change, is fitted to the hour;
> Her mirror is turned forward, to reflect
> The promise of the future, not the past.

Herbert C. Hoover—American Citizen

GREAT as was the professional part played by engineers during the war, to none of them was it given in such great measure as to Mr. HOOVER to direct the economic forces that were so vital to the success of the conflict; to no other private citizen of the United States was it given to emerge from five years of arduous labor as an outstanding world figure, known, respected and honored among the nations of the earth. Small wonder, then, that the American Institute of Mining and Metallurgical Engineers took advantage of the occasion of Mr. HOOVER'S return to this country to do him honor, and at the same time bring the profession of engineering into the reflected light of his glory. His career and record are not only a refutation of the charge that engineers take slight interest in public affairs, but they exemplify the peculiar fitness and ability of the well-trained engineer for the administration of large public affairs.

It has not been uncommon for the average citizen to express surprise that HOOVER, the mining engineer, should have been so successful in the rôles he has undertaken and performed so well. That is because of an erroneous public impression of the nature and character of engineering. As was so pertinently pointed out by Mr. SAUNDERS in his introduction of Mr. HOOVER at the dinner, the modern definition of engineering is that lettered on the wall of the Engineering Societies' library in New York—"Engineering, the art of organizing and directing men, and controlling the forces and materials of nature for the benefit of the human race." In every detail Mr. HOOVER'S work of the past five years has come within the scope of the definition; men in large numbers have been organized and directed, and the forces and materials of nature have been controlled for the benefit of the human race. The combination comprises engineering, and the man who has shown ability to compass the task has proved himself in the highest degree an engineer.

A brief account of the dinner in Mr. HOOVER'S honor, and his address on that occasion are printed elsewhere in this issue. We commend a careful reading of the latter because it presents the first-hand observations and the sound judgment of an intelligent student of world problems since the Armistice.

We deem it appropriate, in the interest of straight thinking among our people, to give it as wide publicity as possible.

Fifth National Exposition of Chemical Industries

THE Fifth National Exposition of Chemical Industries, which Chicago papers called the first, opened on the minute Monday, September 22. Lack of space in the Coliseum required that the First Regiment Armory also be engaged, making it like a train in two sections.

Praise is due both to the management and the exhibitors for being ready when the doors opened.

The exhibits while growing in scope are developing a popular side. Charts showing the steps of processes were much more generally displayed. There was also a greater amount of miniature apparatus, some of which was in operation, and it was very illuminating. It was not only instructive to the curious but showed clearly the scope and requirements of a plant or department to make a given product. A noteworthy feature was that the exhibitors had learned better how to exhibit and we shall comment on this in notes on the Exposition. On the whole it was the best show that has been held and we extend to the management our felicitations.

More Power to the Bureau of Mines!

A SIGNIFICANT milestone in the history of the Bureau of Mines was passed a few days ago with the dedication of its handsome new Pittsburgh laboratories, no less a monument to the broad vision of Dr. HOLMES, the first director, and his associates than to the constancy of purpose with which their successors have built upon this foundation. Any institution which starts on a serious campaign for the conservation of life and resources in any industry truly has an ever-widening field awaiting it.

When the Bureau was first proposed more than a little opposition arose from those who failed to see where a governmental department could effectively cooperate with the mining industry without assuming dictatorial powers so disagreeable to Americans. Few indeed are the critics now remaining. Time has shown how scientific investigation by an organization with no mandatory powers but properly officered can safeguard the life of the miner and smelterman, how this organization of specialists can investigate methods of treating refractory ores, methods of winning fuels from unusual sources, methods of proper utilization of our easily-mined supplies so as to involve minimum wastage before the product reaches the hands of the consumer.

More power to the Bureau of Mines! More funds for its important investigations! More research men of highest caliber to explore mining and metallurgical byways, and more competent engineers to interpret their discoveries to the industry!

May its future be as honorable and influential as its past.

The Steel Strike An Object Lesson

THE steel strike turns the pitiless light of publicity upon policies of labor agitators that have been growing more common and connects the most reprehensible practices with the organized labor that is sponsored by the American Federation of Labor and its head, SAMUEL GOMPERS, who has been referred to in many quarters as the second president of the United States.

Something, and something big, is going to come of this. The Senate has been investigating it. The White House conference on labor to be held October 6 cannot avoid considering it. The campaign to "organize" the iron and steel industry was initiated at the annual convention of the American Federation of Labor at St. Paul in June, 1918. The organization campaign was conducted under the auspices of 24 unions, affiliated with the A. F. of L., but when the strike call was persisted in at least one of those unions withdrew and ordered its locals not to participate.

The organization campaign was directed chiefly at common labor, and was successful only with ignorant foreign-born common labor. The strike committee approached Judge GARY, chairman of the Steel Corporation, for a "conference," was refused, and approached no other manufacturer. The strike call followed, for September 22, and the first two days of the strike threw idle about one-third the iron and steel producing capacity, almost wholly because foreign-born common labor struck while other labor was intimidated.

The issue was collective bargaining and the closed shop, bargaining with labor agitators who pretended to represent men because they had collected $3 each from them, the "organizer" getting $2 commission, one of the twelve points in the organization platform being the "check-off" whereby the collection of subsequent sums, $3 or other amounts, would be made sure.

Surrender meant eventual relinquishment of practically all property rights, while no compromise ground was conceivable. The agitators might have been content with less than all at the outset, knowing that eventually they were certain to get all. The only questions therefore are of the time and hardships involved while the manufacturers win the strike and the influence these events will have upon the general labor situation. During the strike men willing to work will be prevented from working by intimidation. Consumers of steel will have their supplies curtailed, and as steel is used in almost all work, the whole country will be seriously inconvenienced. There are no stocks of steel that will help materially.

The American Federation of Labor can be held responsible for this effort to disturb a peaceful industry, on whose operation the welfare of the major part of the public is more or less dependent, to incite riot and bloodshed, for that is what it means in actual substance, and in fact to start a bolshevist revolution.

Here are two issues, the closed shop and the revolution. Mr. WILSON, years before he became President, declared himself to be "a fierce partisan" of the open shop. Let us hope he is so still. He will have much to do with conducting the deliberations of the coming White House conference on labor.

Readers' Views and Comments

A New Compensated Heatmeter

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the Sept. 1 issue of CHEMICAL & METALLURGICAL ENGINEERING, a "New Compensated Heatmeter" is described by Mr. Charles P. Frey. It is the purpose of this note to call the attention of the author to the fact that the use of "heatmeter" for an instrument which is in no way used to measure quantities of heat is a misnomer and should be carefully avoided. The instrument described measures temperatures by measuring the current produced when the junction of two thermocouple wires is maintained at a temperature different from the temperature of the other ends which are joined either directly or indirectly to the instrument. The use of "heatmeter" for an instrument which indicates temperatures may not seem to some to be much of an error, but they should realize that such practice is the same as using the words "temperature" and "heat" synonymously. The proper use of these two words is one of the first things the high school boy is taught upon taking up his first introduction to the subject of heat in his elementary physics.

The author also states that an ammeter is substituted in place of a pyrometer. In fact the instrument, together with thermocouple, is only a pyrometer in which an ammeter is used to indicate the effect due to a thermo-electromotive force being maintained in a circuit instead of a potentiometer, galvanometer, etc.

If the Brown Instrument Co. wishes its instrument to make a favorable impression in the eyes of the public, it would be better to advertise it under one of the usual names or at least one that is not misleading.

T. S. TAYLOR,
Research Physicist.

Westinghouse Research Laboratory,
East Pittsburgh, Pa.

War Department Deserts Chemical Warfare Service

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am enclosing herewith a copy of a letter by Prof. B. B. Freud of the Armour Institute of Technology, Chicago.[1] A copy of his original letter was sent to the Secretary of War and promptly routed through military channels to me for remark. I am also enclosing a copy of my remarks, which you are at liberty to use if you so desire.

AMOS A. FRIES,
Lt.-Col. C. W. S.

Edgewood Arsenal,
Edgewood, Md.

From: Commanding Officer, Edgewood Arsenal, Edgewood, Md.
To: Director, Chemical Warfare Service, Washington, D. C.
Subject: Accompanying correspondence of Capt. B. B. Freud.

1. Submitted herewith are my observations in regard to the attached letter from Prof. Freud to the Editor, CHEMICAL & METALLURGICAL ENGINEERING, a copy of which was forwarded to the Secretary of War.

2. Capt. Freud was commissioned a Captain, Chemical Warfare Service, without previous military experience or even training in gas warfare, on July 27, 1918. Less than a month later he sailed for France, where he was first assigned to the laboratory in Paris. The assignment was very shortly revoked and he was sent to the gas school at Hanlon Field. He completed the courses there on Oct. 12, and thereafter, until the armistice, he was connected with gas experimentation at Hanlon Field. He was returned to the United States promptly when the war ended, receiving his discharge Dec. 24, 1918.

3. Capt. Freud thus had no field experience, nor did he serve long enough in France to get acquainted with the actual work of the Chemical Warfare Service. So far as known, Capt. Freud was never near the front line. He never got really acquainted with the activities of a Division gas officer, nor did he take any part whatever in the training or operations of gas troops. His case is one of the best examples that has ever come to my knowledge of the danger of "a little learning."

4. Taking in order the remarks of Capt. Freud, we find him first referring to gas masks. The best answer to his questions as to why the study of chemicals for gas masks should not be under chemists and physicists and why the production of finished masks should not be under the Ordnance Department is to ask why the study of diseases and their cure should not be under chemists and physicists and not under the Medical Department, or why the manufacture of medicines, surgical instruments and other implements used by the medical profession should not be under the Ordnance Department or the Corps of Engineers.

5. That sort of thing is exactly what was tried in chemical warfare, in the beginning of the war, and found to be an utter failure. When I was made Chief of the Gas Service in France the various activities now under the Chemical Warfare Service were subdivided among the Corps of Engineers, the Medical Department and the Ordnance Department, respectively, while for research and experiment it was necessary to deal directly with the Bureau of Mines in the United States. Before my assignment an officer of the Medical Department had been given broad powers under which to act on gas matters, and yet we were getting no masks, no training and no decision on gases to be used or shells or bombs in which to put them. Indeed we were getting no action on anything concerning chemical warfare in the field.

6. Everybody's business was nobody's business, as usual. No one had any special interest in chemical warfare or incentive to do anything beyond absolutely necessary routine. If there be any reason in Capt. Freud's remarks, why should not the Veterinary Corps be charged with the care of our sick and wounded and the cost of a highly trained medical profession be eliminated? In other words, Why specialists? Why the Armour Institute of Technology? Why not have all its work done in high schools or in any other place than a special institute?

7. Next, Capt. Freud speaks on gas training and classes it as "a purely military matter." He goes on to state that it should be a part of the line officer's work. Yes, why not? Why not do away with all officers and let the Army be run entirely by non-commissioned officers? That would be vastly cheaper and simpler and would do away with a host of grades and organizations. Capt. Freud closes his remarks in regard to training by stating that: "Certainly scientists are not necessary

---

[1] Prof. Freud's letter has been published in CHEM. & MET. ENG. vol. 21, No. 6, Sept. 15, 1919, p. 274.

for this duty.'" Let us see. I finally put at the head of gas training in France none other than Prof. G. N. Lewis (Lieutenant-Colonel, C. W. S.), head of physical chemistry, University of California, and one of the ablest and best known physical chemists in the world. I did this after two regular officers had been tried in the position and had failed. Col. Lewis succeeded because of his wide knowledge of chemistry, to which was added a highly trained mind with great vision and wonderful capacity to realize the possibilities of gas and the best methods of combating it.

8. Does not Capt. Freud know that the thoroughly trained gas officer needs a wider knowledge of all military tactics, of meteorology and of the topography of the battlefield than any other officer? Does he not realize that the weather, the woods, the knolls, the ravines, the wind and the sun must be taken into account not only with gases in general, but with each gas in particular? If this is not a job for specialists, then there is no need on earth for specialists.

9. Can your line officer be expected to acquire such knowledge or ability when rifle practice, hand-grenade throwing, machine-gun firing, and all the other multitudinous details that are required to make a highly efficient officer command all and more than all of his time?

10. Capt. Freud speaks also of the necessity of somebody writing a text on "Military Gases" of the same general character as Weaver's "Military Explosives." Weaver's "Military Explosives" was an excellent book in its day, but it is now out of date. Military gases and gas tactics of 1917 were out of date in 1918. Those of 1918 will be out of date in 1920. If we do not keep up with research, development, manufacture and training in gas, we, too, will be out of date, and *God pity us in the next war!*

11. Capt. Freud states that the offensive use of gas is largely an artillery problem and then suggests that gas troops might be put under the Engineers. This shows Capt. Freud's complete ignorance of the field of usefulness of gas troops. He apparently is not aware that the first regiment of gas troops was raised under the Corps of Engineers, and what happened? They were put on road work following the beginning of the Marne offensive and only relieved after their Colonel begged that they be given a chance to clean out German machine-gun nests that were killing our boys by the hundreds. This and other work they did so successfully that the General Staff, A. E. F., increased the gas companies to be used in the campaign in the spring of 1919 from 6 to 54; that is, the Staff increased them to nine times their original strength.

12. Capt. Freud believes that there should be a soldier-chemist on the staff of each Division. We had them, so far as possible, in the last war, but we also had three other officers, and each one of the four was kept busy to the absolute limit of his ability to cover the various requirements of the Commanding General concerning chemical warfare—and chemical warfare was only in its infancy.

13. Capt. Freud sums up and says it seems to him that the proper activities of the Chemical Warfare Service can be apportioned among the different Departments of the Army. Unquestionably, so might the activities of the Armour Institute be divided up among the country schools of Illinois. Unquestionably, if we wanted to revert to former weapons, we could abandon all organizations and modern forms of warfare, and hence all technical services, and go back to the old short Roman sword—the deadliest weapon of warfare ever invented by man. Considering the highly complicated nature of gases and the need of research, experimentation, development and manufacture, it would be just as reasonable to state that the work of our colleges could be divided up among the country schools and the college done away with as to divide the proper work of the Chemical Warfare Service among other Departments of the Army.

14. In simple words again, Why specialists at all? As stated in the beginning, Capt. Freud furnishes the finest example I have ever known of the danger of "a little learning."

AMOS A. FRIES.
Lt. Colonel, C. W. S.

Glucinum

To the Editor of Chemical & Metallurgical Engineering

SIR:—With reference to the article on Glucinum, published in CHEMICAL & METALLURGICAL ENGINEERING, Sept. 15, 1919, page 353, the use of the name Glucinum instead of Beryllium has been brought to my attention as needing some elucidation.

Since the publication of the first memoir by Vauquelin in 1798, to which is appended the editor's note using the word Glucine as the technical name of the Terre de Béril, there has been published a voluminous series of papers on "Glucinum or Beryllium" and "Beryllium or Glucinum" and it seems that the Gordian knot is not yet cut. French technical literature uses exclusively the names Glucine (from γλυκύς, sweet, as one of the characteristic properties of its salts is a sweet taste) and Glucinium as analogous to alumine and aluminium. The Germans translated Terre de Béril to Beryllerde, and they have their analogies: Beryllerde-Beryllium and Thonerde-Aluminium. In consulting the indices of the technical literature printed in English, one will find sometimes under Beryllium, "see Glucinum," and quite as many times under Glucinum, "see Beryllium."

Without going into the details of the printed discussions as to a proper name for this "chameleon element",[1] it may be sufficient to state that when I used the word Glucinum I was aware of the existence of practically all that is written on this subject.

Dr. Charles L. Parsons strongly advocates the name Beryllium, giving as the two reasons, priority and usage,[2] and sides with the "ninety and nine"[3] who are using this term, although some time before 1905 the American Association on the Spelling and Pronunciation of Chemical Terms did recommend the term Glucinum.

With the French it is not only a matter of priority and usage, but also that the sound of Glucine and Glucinium is far more harmonious and more expressive than Terre de Béril and Bérillium, and this no doubt deserves to be taken into consideration when new words are to be created. With the Germans, on the other hand, it is strictly a matter of *magister dixit*. The translator of Vauquelin's memoir used Beryllerde in 1798 and Wöhler in 1828 wrote about Beryllium, *ergo* Beryllerde and Beryllium must be as immutable as Tonerde[4] and Aluminium. With the English-speaking technical man the use of Glucinum or Beryllium is, in the great majority of cases, determined by his *alma mater*.

---

[1] Dr. J. Emerson Reynolds, *Chemical News*, July 9, 1883, p. 9.

[2] Dr. Charles L. Parsons, *Science*, Dec. 9, 1904, pp. 809-810.

[3] Dr. Charles L. Parsons, *Science*, Feb. 17, 1905, p. 273.

[4] Some changes have been made a few years ago in the German chemical nomenclature. Among these: The name Thonerde, which stands for Al_2O_3, is now Tonerde.

Some writers favor Beryllia, because the use of Glucina (French, glucine), GlO, might lead to its being confused with glycine, $C_2H_5NO_2$. It is a fact that the sounds of the French *u* and *y* in glucine and glycine are hardly distinguishable to those who are not indigenous and with a chemical education, and still the Frenchmen use exclusively Glucine. The Germans and the English-speaking people cannot claim that such an argument favors their choice of Beryllerde or Beryllia.

As to whether the English and American technical men shall use Beryllium in preference to Glucinum, I submit the following important authorities: *Journal of the Chemical Society*, London, and *Chemical News* both index Glucinum and not Beryllium (See *J. Chem. Soc.*, bound vol. 114, 1918, etc., and *Chemical News*, bound vol. 109-110, 1914, etc.); Bulletin 624, U. S. G. S., describes the mineral Beryl as a Glucinum-Aluminum silicate; the Van Nostrand Chemical Annual, 1918, uses Glucinum, and only in a few places is the word Beryllium mentioned and then only in parentheses after the word Glucinum; the Chemist's Pocket Manual, 1918, uses Glucinum; lastly, the Condensed Chemical Dictionary, edited by the editorial staff of the *Chemical Engineering Catalog*[5], just issued (September, 1919), indexes on page 104 "Beryllium; see Glucinum," on page 243 "Glucinum (Beryllium)," and on page 503 "Glucinum."

In conclusion I will quote what Professor James Lewis Howe stated about 15 years ago: "With French, English and Americans using 'Glucinum,' we can afford to let the Germans cling to 'Beryllium' a little while longer."[6] J. S. NEGRU.

New York City.

Western Chemical and Metallurgical Field

Potash Salts

NO ACTION has as yet been taken by the Ways and Means Committee regarding the bill to license potash importations. Rather the opposite—in order to provide the necessary additional potash needed this fall by the agricultural industry in addition to that produced from American sources, a recent Executive order opens the door to potash regardless of the fact that it may have been produced in Germany.

Whether the German or Alsatian supplies are sufficient for our needs remains to be seen. Conditions in Germany as regards potash are in an uncertain and disorganized state. There are no large quantities of potash available for export to this country, labor conditions are uncertain, the mines are wholly run down, transportation difficulties are many, and the coal shortage has been acute for some time. Shipping facilities are also in an uncertain condition. For these reasons, the Bureau of Mines states, the quantity of potash which may be expected to come out of Germany this fall is hard to estimate. The general director of the Potash Syndicate believes that Germany may be able to supply all the potash salts needed of the lower grades, provided boats are secured.

In addition to these uncertainties, there is also the question of what the national policy of Germany with regard to potash will be. There may be heavy taxes placed on the export of potash to raise revenue.

In Alsace it is reported that on the first of July there were from 15,000 to 20,000 tons, but that this was largely needed for domestic use. It has been estimated by H. S. Gale that there may be available during the next year, that is, up to the middle of 1920, 50,000 tons of pure potash from Alsace and an equal quantity from Germany, which together would not be nearly enough to satisfy our pre-war requirements. It is reported that the accumulated stocks of Nebraska potash have all been sold.

Alpha-Naphthol and Xylidine Mixture as Flotation Agent

The annual report of the Consolidated Coppermines Co. contains interesting information as to the results obtained in its concentrating operations during the past year and a half. Previous to Sept. 1, 1918, a coal-tar composition consisting of a mixture of coal-tar, coal-tar creosote and No. 80 Pensacola pine oil was used in the flotation cells. Since that date a mixture of alpha-naphthol and xylidine in an alkaline circuit has been used with very encouraging results. The concentrating ratio has been increased from 14.68 to 17.0 to 1, and the moisture content of the filter cake reduced from 17.15 per cent to 9.39 per cent. The increased cost of reagents from 7.46c. to 15.6c. per ton milled was more than offset by the decrease in freight and smelter charges of more than half and by a threefold increase in the capacity of the filter presses. In summarizing the results, H. S. Munroe states that the "operations for the year demonstrated that with a 1.4 per cent copper millhead and with a properly designed and operated mill the following results may be obtained:

"First: A concentrate containing 18 per cent copper may be produced.

"Second: The iron, sulphur and insoluble content may be governed within such limits as to permit of smelting this material with less than 20 per cent of barren flux.

"Third: The moisture of this concentrate may be held at 10 per cent or less."

A tabulation shows a comparison of results with the coal-tar float reagent and the X-cake reagent.

COAL-TAR REAGENTS

	Per Cent Copper	Oz. Gold	Oz. Silver	Per Cent				
				SiO_2	Al_2O_3	Fe	CaO	S
Analysis mill heads	1.186	0.018	0.059	87.1	1.5	3.5	2.1	2.1
Analysis mill tails	0.277	0.009	0.039	91.5	1.1	2.2	2.2	0.5
Analysis concentrates	13.623	0.140	0.329	27.3	7.2	20.9	1.3	22.9
Percentage recovery	78.22	52.95	38.11	2.14	32.81	40.84	4.24	75.65

Concentration ratio, 14.68 into 1.
Per cent H_2O in concentrate, 17.15.
Cost float reagents per ton milled, 7.46 cents.

X-Cake–Xylidine Reagents

	Per Cent Copper	Oz. Gold	Oz. Silver	Per Cent				
				SiO_2	Al_2O_3	Fe	CaO	S
Analysis mill heads	1.336	0.019	0.07	85.9	2.5	3.7	2.5	2.5
Analysis mill tails	0.206	0.006	0.04	90.1	2.3	2.1	2.6	0.5
Analysis concentrates	18.33	0.210	0.436	13.5	4.5	27.6	0.3	32.1
Percentage recovery	82.31	69.30	40.34	0.97	12.02	46.61	0.64	80.79

Concentration ratio, 17.00 into 1.
Percent H_2O in concentrate, 9.39.
Cost float reagents per ton milled, 15.6 cents.

War Risk Insurance

The Bureau of War Risk Insurance advises that it is prepared to furnish a special service in regard to war risk insurance, allotment and compensation matters. Replies to questions on these subjects will be furnished within 48 hours.

---

[5] The Condensed Chemical Dictionary, 1st Ed., 1919, the Chemical Catalog Co., Inc., New York.

[6] *Science*, vol. 21, Jan. 6, 1905, p. 36.

Mining Engineers Honor Hoover

HERBERT C. HOOVER was the guest of honor at a dinner given by the American Institute of Mining & Metallurgical Engineers at the Waldorf-Astoria, New York City, Tuesday evening, Sept. 16. The event commemorated his return to private life after 5 years of arduous service in administering the food supplies of many nations and participating in the economic readjustment of Europe after the Armistice. Over 1200 members of the Institute responded to the opportunity to honor their eminent fellow engineer, and the occasion was one not often paralleled, if equaled.

In the course of the evening those present were presented with a photograph of Mr. Hoover which had been provided by the committee on arrangements.

President Horace V. Winchell opened the exercises with a brief tribute to the ability and genius of the guest of honor, who has shown us that "the biscuit is mightier than the bomb." President Winchell then read letters and telegrams from various organizations and individuals, all paying tribute to Mr. Hoover's work. These messages came from: Brussels University, Robert W. Hunt, H. A. Garfield, J. C. Branner, American Engineers in London, Messrs. Honnold and Shaler, Institute of Mining & Metallurgy, Commission for Relief in Belgium, L. D. Ricketts, Members of the A. I. M. E. in London, Van H. Manning, Belgian Society of Engineers and Manufacturers of Brussels, John Hays Hammond, Trustees of Stanford University, Charles T. Neal, D. W. Brunton, Charles M. Schwab, the Commonwealth of California, Joint Council of San Francisco Engineering Societies and Henry M. Howe.

President Winchell then introduced W. L. Saunders, past president of the A. I. M. E., who acted as toastmaster. Mr. Saunders repeatedly evoked applause and cheers by his reference to the work and character of Mr. Hoover, and when he made reference to the fact that men like Hoover "are, by education and experience, best fitted to steer the ship of State" he brought the entire audience to its feet with cheers of approval for the evident political import of the remark.

Mr. Hoover responded with a brief expression of gratitude for the honor shown him and then delivered a formal address on some of the impressions gained during his service in Europe since the armistice. This address we deem of sufficient importance in these trying times to reproduce in full.

Mr. Hoover's Address

I have been asked to speak to you on some of the impressions that I have gained during my service in Europe since the armistice. Two convictions are dominant in my mind. The first comes from contact with stupendous social ferment and revolution in which Europe is attempting to find solution for all its social ills by practical experiments in Socialism. My conviction is that this whole philosophy is bankrupting itself from a startling quarter in the extraordinary lowering of productivity of industrial commodities to a point that, until the recent realization of this bankruptcy, was below the necessity for continued existence of their millions of people. My second conviction is older but has been greatly hardened, and that is a greater appreciation of the enormous distance that we of America have grown away from Europe in the century and a half of our national existence, in our outlook on life, our relations toward our neighbors, and our social and political ideals. The supreme importance of this Americanism neither permits us to allow the use of this community for experiment in social diseases, nor does it permit us to abandon the moral leadership we have undertaken of restoring order in the world.

ECONOMIC EXHAUSTION RAMPANT

During the last ten months I and my colleagues have occupied a unique position in intimate witness of the social currents that have surged back and forward across Europe. The enemy collapsed not only from military and naval defeat but from total economic exhaustion. In this race to economic chaos the European Allies were not far behind. By this exhaustion the whole of Europe stood facing a famine, the like of which has not been seen since the Thirty Years' War, when a third of the population died of starvation. In the midst of all this was the struggle of a score of new democracies to establish themselves, with friction along every frontier, and with the destruction of governmental institutions, without financial resources to buy supplies, with the miseries of their people offering fertile soil for every economic patent medicine and for all the forces of disorder, and Bolshevism and anarchy overhanging all, there could be no hope of restoring normal economic life until the completion of peace. In all this situation, with its desperation, greed, century-old animosities, its idealistic and proper aspirations, there was only one hope. That hope, expressed by every city and state, was that the American people, being the one disinterested and uncrippled economic and political force still existing in the world, should again intervene. It was in response to this call that the President, comprehending the real heart of the American people, intervened in Europe a second time and took those steps which resulted in a practical economic organization of Europe, pending the consummation of peace and the arrival of the forthcoming harvest.

PROBLEM OF THE SECOND INTERVENTION

This second intervention was not a relief problem in the ordinary acceptance. It was not a problem alone of finding foodstuffs for starving populations of the ravaged regions. It was the problem of finding a large margin of foodstuffs and other supplies for the whole of Europe—Allies, liberated peoples, neutrals, and enemies; and in a mass of at least 200 millions of these people formerly under enemy domination it was a problem of finding absolute economic rehabilitation. Further than this, it was a problem of warding off Bolshevism on one side and reaction on the other, in order that the new-born democracies could have an opportunity of growth. Its practical consummation was a problem of the organization of the economic strength of the United States and its co-ordination with the remaining economic strength of Europe, and, in large areas, the imposition of absolute dictatorship over economic forces.

Thus, the shipping of the world required sufficient co-ordination to transport thirty millions of tons of supplies from all quarters of the globe to Europe. It required the provision of credits to those countries whose total exhaustion abolished all hope of normal payment. It required the insistence upon payment from those who had gold or commodities. It required sufficient co-ordination of purchase in this vast quantity of supplies that the markets of the world should be affected in the least possible degree. With the dissolution of the organization of the old channels of communication, river craft and railway rolling stock was hoarded by each state; telegraph and postal communications were broken down; every frontier was the scene of more or less military friction, until at one moment there were twenty-five little wars in progress. Many of these new governments were without experience or even without the existence of departments for the conduct of either the transportation or distribution of supplies.

Thus, it was necessary to secure the erection within their governments of actual departments, to furnish them advisors, to take over the actual operation of thousands of miles of disintegrated railway systems, to open rivers and canals for traffic, to stimulate the production of coal and other primary commodities, to control their distribution through large areas, to find a basis for exchange of surplus commodities from one state to another, to exercise the strongest political pressure to obtain the disgorgement of surpluses into areas of famine, to resort to barter on a national scale where currencies had broken down, to stimulate peoples discouraged and disheartened to efforts in their own salvation, and, finally, but not least, to intervene a charitable hand in the saving of their children and the stamping out of contagious diseases, and through all of this economic disorganization to inspire the maintenance of order on one hand and the defeat of reaction on the other. Beyond this again, the necessity of constant friendly intervention in frontier quarrels to prevent the starting of more wars.

Co-ordination Solved the Problem

These things have not been solved by the service or direction of any one man. They have been accomplished through co-ordination of the men of good will in twenty governments of Europe and throughout by creation of a thread of American personnel, directed from a single center. On our side it has required the co-operation of Congress, the Grain Corporation, the Treasury, the Shipping Board, the Army, and the Navy. A thousand Americans were sent into those communities with but little authority beyond their own assurance and the confidence on all sides that they were disinterested, that their only desire was to solve a great and human emergency for no political and no commercial advantage. It was our desire to do this from the background, without ostentation; to act at all times through established institutions, to build up their strength for the time they must rely upon their own resources. I cannot pay enough tribute to all these thousand Americans, many of them engineers, men taken from the common life of the United States, thrust into the face of staggering political, economic problems, the solution of which must affect the well-being not of hundreds but of millions. The proof of their performance lay in the fact that Europe has come through the most terrible period of its history with no loss of life from economic causes, with a stronger democracy and a glow in its heart for the United States.

This service of the American people has been accomplished at no mean national sacrifice. From the armistice to this year's harvest there has been furnished over two and a quarter billion dollars' worth of supplies, the majority of which has been given freely upon the undertaking of the assisted governments of repayment at some future date. There has been no demand of special security; no political or economic privileges have been sought. It may be years before we receive any return from these loans, but if that period should never come the American people, by this second intervention in Europe, have saved civilization, and have done so with no thought to the burden or cost to themselves. These matters have been brought to a successful close with the arrival of the harvest and the prospect of peace. What the future has a right to demand from us in further economic support is not yet clear, but it is at least certain that if the world cannot quickly secure the settlement of peace and safeguards for the future through the League the whole of our two great interventions will have gone for nothing, and the menace of reaction will again return against us upon the winds of chaos.

Common People's Condition Improving

As the executive head of this Allied effort in economic control, I have thus had an intimate contact with the common people and their officials. I have witnessed their improving physical condition, the constant change of currents of social, political and economic forces, their revolutions, and I have had to deal ultimately with the results of all these phenomena. During this period since the armistice, we have witnessed social and political revolution among one-third of the civilized world, and we see the remainder in great social tribulation. No contemporary can properly judge or balance the relative volume of great currents of social agitation. They are matters of mind and not of matter. Yet practical statesmanship requires that within our abilities a constant accounting should be taken of the tangible results of these forces abroad, if the development of our liberal institutions and progress of orderly government is to be maintained and revolution avoided.

This cataclysm of social change in Europe is the result of the long culmination of social as well as political wrongs; it is no sudden afterthought of war. These forces were projected into actual realization by the collapse of the war, the breakdown in the political institutions that had preceded it, and the misery that has flowed from it. Our soil is not so fertile as that of Europe to many of these growths, because we have a larger social conscience. We have not the vivid class and economic distinctions of Europe, nor have we the depth of misery out of which these matters can crystallize. Nevertheless, in these days of intimate communication, social forces are rapid in their penetration and social diseases are quick in universal infection.

The general revolution of Europe of the last century, starting with the French Revolution, profoundly changed the whole social order of the world, and, while in that revolution the spiritual impulse was the demand for political liberty, there was also a great economic impulse. That economic impulse was primarily the division of the land, and one of the fruits of that revolution was the better distribution of wealth among the agricultural population. Since that time an enormous expansion of mechanical industrialism has been superimposed upon all agricultural states, with a large increase in urban populations. The economic impulse of the revolution to-day is the demand for a better division of the wealth from this industrialism, and this time the agitation arises mainly from the urban population.

These vast masses of humanity in Europe have long been groping for the method of nearer equality of opportunity and better distribution of the results of industrial production. These gropings and these attempts have in recent years been dominated by Marxian Socialism, developed in different degrees of intensity. Broadly, these revolutions have taken two forms: the Bolshevik form, through which there has been overnight communization of all property, and second, the milder form of legislative nationalization of industry. I believe we are now in position to take some stock of and to form some judgment as to the adequacy of these solutions for what I believe every liberal-minded man believes is a necessity—the better division of industrial production.

EUROPE'S INDUSTRIAL PRODUCTION DEMORALIZED

We require only a superficial survey to see that the outstanding and startling economic phenomenon of Europe today is its demoralized industrial production. Of the 450 million people in Europe, a rough estimate would indicate that they are at least 100 million greater than could be supported on the basis of production, which has never before reached so low an ebb. Prior to the war, this population managed to produce from year to year but a trifling margin of commodities over the necessary consumption and to exchange for supplies from abroad. It is true that in pre-war times Europe managed to maintain armies and navies, together with a numerically small class of non-producers, and to gain slowly in physical improvements and investments abroad, but these luxuries and accumulations were only at the cost of a dangerously low standard of living to a very large number. The productivity of Europe in pre-war times had behind it the intensive stimulus of a high state of economic discipline, the density of populations at all times responded closely to the resulting volume of production. During the war, the intensive organization of economy and consumption, the patriotic stimulus to greater exertion and the addition of women to productive labor, partially balanced the diversion of man-power to war and munitions. Both the pre-war and the war impulses have now been lost, and the productivity of Europe has steadily decreased since the armistice.

It is true that some of this diminution in production has been contributed to by the other factors, but in the larger degree the cause of this steady decrease of productivity, with its shortage of necessary supplies and its rising cost of living, must be sought in the social ferment, with its continuous imposition of Socialistic ideas. In this ferment the advocates of Socialism or Communism have claimed to alone speak for the downtrodden, to alone bespeak human sympathy, and to alone present remedies, to be the single voice of Liberalism.

We may examine these phenomena a little more closely. In Russia we have a great country in which the population, with the exception of a small minority, were comparatively well fed, warmly clothed, and warmly housed. They were subject to the worst of political tyranny, were deliberately steeped in ignorance and superstition, yet their productivity was sufficient to enable them to provide these primary comforts and to export more foodstuffs than the United States. Socialism was brought in overnight at the hands of a small minority of intellectual dilettantes and criminals, and this tyranny of minority, more terrible even than the old, has now had nearly two years in which to effect the conversion of the wicked competitive system into the Elysium of Communism. Today two-thirds of the railroads and three-fourths of the rolling stock that they control are out of operation. The whole population is without any normal comforts of life and plunged into the most grievous famine of centuries. Its people are dying at the rate of hundreds of thousands monthly from starvation and disease. Its capital city has diminished in population from nearly two million to less than 600,000. Prices have risen to fantastic levels. The streets of every city and village have run with the blood of executions, nor have these executions been confined to the so-called middle and upper classes, for latterly the opposition of the workmen and farmers to this regime has brought them also to the firing squad in appalling numbers.

COMMUNISM ACKNOWLEDGING FAILURE

If we examine the recent proclamations of this group of mixed idealists and murderers, we find a radical change in their economic and social ideas. They have abandoned the socialization of the land, for they find the farmer will not produce for payment in high-flown and altruistic phrases. They have re-established a differential wage in an attempt to stimulate the exertion and ambition of skilled labor. They have established a State Savings Bank, in order to stimulate production through making provision for family and old age. They are offering fabulous salaries for men capable of directing the large agencies of production. In fact, while in the midst of flowery verbal endeavor to maintain that they are still Socialists, they are endeavoring to restore individual ownership of property and of the results of labor. The very High Priest of Socialism is today vainly endeavoring to save his people from their total destruction by summoning back the forces of production. The apologists of this debacle are telling us that it is due to the Allied blockade, and to various other oppositions, but any one with a rudimentary knowledge of Russia knows that they did have within their borders ample supplies of food, coal, oil, wool, flax, cotton, and metals and the factories with which to work them in abundance, and that their sole deficiency is human effort.

We could take another example of Bolshevism in the efforts of Bela Kun and his colleagues in Budapest. The distinction between this situation and Russia is that they were dealing with a population of much higher intelligence, of much higher average education, and it required but three months for the working people of Budapest to realize the fearful abyss into which they had been plunged. It was solely due to the efforts of the trade unions in Budapest that the Bolshevists were thrown out of Hungary.

These are the extreme points where Socialism has had its opportunity for immediate and wholesale application, according to all of the precepts of its advocates. Elsewhere in Europe Socialism has proceeded through established institutions, and we may shortly examine the results here also.

During the war large measures were taken on both sides of the front to secure the mobilization of production and distribution to its maximum use in the struggle. There was effective socialization of vast sections of industry. These measures are being continued and extended today in many places by governments anxious to maintain the stability of institutions, even at the sacrifice of economic safety, but under the threat of minorities of revolutionary action. Yet here again the same prime weakness has proved itself. The only partial success of these measures in war was due to the great patriotic impulse of war. Those who conducted these large operations were men whose initiative and capacity had been selected by the competitive system. These war impulses have been lost, and these organizations with constantly decreasing efficiency even in war now face disaster from further reduced productivity. All these decreases have immediate results in a rising cost of living or the necessity of governments to subsidize commodities—such as bread. There is no better example of this than the coal industry of Europe, and even omitting Russia, this production has fallen from a rate of 600 million tons per annum at the armistice to a rate of 450 million tons recently.

The coal industry is in modern life the very lifeblood of the state, and it has proved itself the most susceptible among all the industries to these influences, and its production today is at such an ebb as to jeopardize the entire social fabric. I am convinced that the greatest proportion of European leaders of Socialism today to some extent realize this bankruptcy, and are today endeavoring to cover a retreat with loud complaints as to the failure from other causes. Nevertheless, the realization itself is a great step and is bringing the turn of the tide, and through it Europe is on the road to economic recovery—if she gets peace.

PRIMARY CONCEPTION OF SOCIALISM WRONG

The whole of these various sorts of Socialism are based on one primary conception, and that is that the productivity of the human being can be maintained under the impulse of altruism and that the selection of the particular human for his most productive performance can be made by some superimposed bureaucracy. Their weakness is the disregard of the normal day-to-day primary impulse of the human animal, that is, self-interest for himself or for his family and home, with a certain addition of altruism varying with his racial instinct and his degree of intelligence. They fail to take into account, also, that there is but one sufficiently selective agent for human abilities in that infinite specialization of mind and body necessary to maintain the output of the intricate machinery of production, and that is the primary school of competition.

My emphatic conclusion is, therefore, that Socialism as a philosophy of possible human application is bankrupt.

Although Socialism has now proved itself with rivers of blood and suffering to be an economic and spiritual fallacy and to have wrecked itself on the rock of production, I believe it was necessary for the world to have had this demonstration. Great theoretic and emotional ideas have arisen before in the world's history and have, in their bankruptcy, deluged the world with fearful loss of human life. A purely philosophical view might be that these experiences are necessary to humanity, groping for something better. It is not necessary, however, that we of the United States, now that we have witnessed these results, plunge our own population into these miseries and into a laboratory for experiment in foreign social diseases.

Bankruptcy of the Socialistic idea, however, does not relieve us from the necessity of finding a solution to the primary question which underlies all this discontent. That primary question is the better division of the products of industry and the steady development of higher productivity. This bankruptcy of the Socialist idea should, if reaction is to be prevented, return the guardianship of this problem from the radical world to the liberal world of moderate men, working upon the safe foundations of experience.

SOLUTION OF AMERICAN ISSUES IN AN AMERICAN WAY

The paramount business of every American today is this business of finding a solution to these issues, but this solution must be found by Americans, in a practical American way, based upon American ideas, on American philosophy of life. A definite American substitute is needed for these disintegrating theories of Europe. It must be founded on our national instincts and upon the normal development of our national institutions. It must be founded, too, upon the fundamental fact that every section of this nation, the farmer, the industrial worker, the professional man, the employer, are all absolutely interdependent upon each other in this task of maximum production and the better distribution of its results. It must be founded upon the maximum exertion of every individual within his physical ability and upon the reduction of waste both nationally and individually. We can well see a vivid confirmation in Europe of the fundamental economic principle that the standard of living and the cost of living is the direct quotient of the amount of commodities produced; that we must secure a maximum production of the industrial machine if we wish to keep our population alive or if we wish to see an increase in the standard of living of our people. From this only can arise the very foundations of the higher activities of life. The application of this proposition must, however, stand several tests. A maximum production can only be obtained under conditions that protect and stimulate the physical and intellectual well-being of the producer. We shall never remedy justifiable discontent until we eradicate the misery which the ruthlessness of individualism has imposed upon a minority.

If I were thinking aloud I would say at once that this maximum production cannot be obtained without giving a voice in the administration of production to all sections of the community concerned in the specific problem; that it cannot be obtained by the domination of any one element. I would say that the human race had increased its standards of productivity and therefore of living through the growth of extraordinarily intricate organization of production and distribution based upon stimulation of the individual by the reward it offers. I would also say that it cannot be obtained from the destruction or sudden disturbance of this delicate and intricate organization of production and distribution or extravagance in its products. I would say the road lies along the better division of the more exorbitant profits that arise from these processes and that have accumulated from them. By better division of profits, I do not refer particularly to profit-sharing schemes but to the broad issue of the whole social product. Some are comparatively overpaid, and many comparatively underpaid, for the service they render to the community. Our organization in many aspects is not all that we could desire, but it is the best we have been able to evolve over thousands of years, and the destruction of these processes or of the organization which conducts them has been demonstrated to be the sure road to destitution and fearful loss of life.

It is not that we today have suddenly awakened to this necessity for better distribution of profits. The social conscience of this country has been manifesting itself continuously concerning this matter for years. We have in the United States today a better division of wealth and a greater equality of opportunity than any other nation in the world, and we have thus better foundation upon which to build. We have reason for discontent in the fact that our industrial development has outrun our social progress, and we have reason to hasten those measures that lead to larger justice in distribution of these profits, larger representation of all elements of the community in the control of these agencies to further strengthen our measures for the restraint of economic domination by the few and for the liquidation into the hands of the many of the larger industrial accumulations in the hands of the few that our rapid development has made possible.

Again I wish to repeat, the observation of these forces in Europe has reinforced my Americanism during these last ten months of intimate contact with them; it has revealed to me the distance of our departure from the political, social, and economic ideals of Europe. There has grown in this United States a higher sense of justice, of neighborly service, of self-sacrifice, and, above all, a willingness to abide by the will of the majority in every section of this community. This Americanism is the guarantee of the ability of our people tó solve this most momentous internal problem confronting our generation. But these very ideals, this very sense of justice and service for our own people, gives us still further opportunities.

Our sister civilization in Europe is today recovering from a great illness. The many new democracies that we have inspired are striving for our ideals. We alone have the economic and moral reserve with which to carry our neighbor back to strength. To do this is also true Americanism.

During the evening Mr. Hoover was presented with an illuminated testimonial, a copy of which follows:

To

HERBERT HOOVER

THE Members and Guests of the American Institute of Mining & Metallurgical Engineers, assembled to commemorate his return home, extend the ***Welcome*** due an eminent American Citizen, a successful Engineer, a Genius of Constructive Administration, a practical Economist, a Statesman of World Vision.

In him they honor an Idealist who was able to vitalize the Altruism of America and save from Hunger and Anarchy vast areas of Europe where millions of men, women and children in a score of languages lift their voices to call him blessed.

He is loved and honored for his gift of leadership and inspiration which called many thousands of volunteers to his aid in the great tasks he undertook and accomplished.

Realizing that no gift of gold or precious stones could convey the deep feeling of appreciation we wish to express, we simply subscribe our names as fellow engineers, coworkers and admiring friends.

The World's Merchant Marine Tonnage

Lloyds Register for 1919-20, issued in August, shows that the world's total merchant tonnage is now 50,919,000 gross tons, compared with 49,090,000 gross tons in 1914, just before the outbreak of the European war. The totals of the steam gross tonnage in round numbers of the principal countries for the two years are separately stated. The 1919 steam tonnage for Germany is for the time of the armistice, and as Germany ceded to the Allies all ships over 1600 gross tons and from one-fourth to one-half of the remaining smaller ships, the actual German tonnage will be about 700,000 gross tons, and 2,550,000 gross tons will be divided among the Allies proportioned to war losses. Sail tonnage (net) comprises a small and diminishing part of the world's shipping and is added in at the end of the three columns following:

Countries	June, 1914 Gross Tons	June, 1919 Gross Tons	Increase (+) or decrease (— Gross Ton
United Kingdom	18,892,000	16,345,000	—2,547,000
British Dominions	1,632,000	1,863,000	+ 231,000
United States:			
Seagoing	2,027,000	9,773,000	+7,746,000
Great Lakes	2,260,000	2,160,000	— 100,000
Austria-Hungary	1,052,000	713,000	— 339,000
Denmark	770,000	631,000	— 139,000
France	1,922,000	1,962,000	+ 40,000
Germany	5,135,000	3,247,000	—1,888,000
Greece	821,000	291,000	— 530,000
Holland	1,472,000	1,574,000	+ 102,000
Italy	1,430,000	1,238,000	— 192,000
Japan	1,708,000	2,325,000	+ 617,000
Norway	1,957,000	1,597,000	— 360,000
Spain	884,000	709,000	— 175,000
Sweden	1,015,000	917,000	— 98,000
Other countries	2,427,000	2,552,000	+ 125,000
Total steam tonnage	45,404,000	47,897,000	+2,493,000
Sail tonnage (net)	3,686,000	3,022,000	— 664,000
Grand total	49,090,000	50,919,000	+ 1,829,000

An Engineering Course for College Professors

A banquet in the officials' dining room marked the closing of the annual summer course for engineering teachers at the East Pittsburgh works of the Westinghouse Electric & Manufacturing Co. Eleven college professors, representing institutions all the way from Brooklyn, N. Y., to Tokyo, were in attendance.

The course just completed was of a month's duration and was composed of inspection trips throughout the plant, observation of work, and of lectures and talks by the various experts of the company. A feature introduced at the lectures was the motion picture to portray the work of modern electricity. Two of the reels of the most interest were "A Romance of the Rails" and "A Trip Through the 74th Street Power House." The "Romance of the Rails" showed the advance in present-day railroading by electrification of steam roads and the passing of steam as motive power. The trip through the power house exhibited the 70,000-kw. turbine of the Interborough Rapid Transit Co. of New York City. This turbine, which was built and installed by the Westinghouse company, is the most powerful engine in the world.

The professors who were in attendance at the summer course and the institutions they represent are: M. P. Cleghorn of Iowa State College, W. D. Emerson of the University of Maine, R. S. Howell of the Georgia Institute of Technology, L. J. Hodgins of Maryland State College, J. E. Lear of the University of North Carolina, B. K. Northrop of Cornell University, S. Noda of the Imperial University of Japan, C. W. Piper of Purdue University, J. W. Shuster of the University of Wisconsin, A. F. Puchstein of the Ohio State University and E. B. Wood of Pratt Institue.

International Union of Pure and Applied Chemistry

THE July meeting of the Interallied Chemical Confederation[1] in London was devoted to the adoption of the statutes of the International Union of Pure and Applied Chemistry.

Previous to adjournment the Conference officially appointed members of its own body as their representatives, to attend the Brussels meeting of the International Research Council on July 22, for the purpose of effecting the union of the new international chemical organization with the International Research Council as its chemical branch, and for the purpose of making such necessary alterations in the statutes which have been adopted as might become necessary in uniting with the International Research Council.

The meeting at Brussels was largely engaged in the discussion, modification and final adoption of the statutes of the new International Union of Pure and Applied Chemistry. These statutes are printed herewith as finally adopted to conform with the statutes of the International Research Council, by and of which the International Union of Pure and Applied Chemistry was constituted the chemical section, in conformity with the resolutions adopted at the London meeting.

STATUTES OF THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY[2]

Article I

1. Each of the following countries—Belgium, United States of America, France, United Kingdom of Great Britain and Ireland, and Italy, through the agency of its National Research Council (Chemistry Division), or its Federal Council of Chemistry, or failing such national federation, through the agency of a national chemistry association, joins with the others in the formation of an International Union of Pure and Applied Chemistry, having for its objects the following:

(*a*) To cement among the allied peoples the bonds of friendship and mutual esteem which have been developed and strengthened during the course of the war.

(*b*) To organize permanent co-operation between the chemical associations of the different countries.

(*c*) To co-ordinate their scientific and technical activities.

(*d*) To contribute to the advancement of chemistry in all its branches.

2. The Union thus constituted shall be perpetual. Its provisional headquarters shall be in Paris.

Article II

1. The conditions governing the admission of a country to the Union shall conform to those fixed by the statutes of the International Research Council.

2. A country may join the Union through its "national chemical federation," e.g., through its National Research Council (Chemistry Division), or through its Federal Council of Chemistry, or failing such organization, through a national association representing chemistry.[3]

Article III

1. The functions of the Union as set forth in Article I shall be exercised through a Council, assisted by an Administrative Secretary and by a special staff or bureau, the establishment and duties of which shall be determined by international agreement among the constituent countries.

Article IV

1. The annual subscription for each country is fixed at a rate dependent upon the number of its inhabitants, in accordance with the following categories:

	Population in Millions of Inhabitants	Minimum Annual Subscription, Francs
Category A....................	Less than 5	500
Category B....................	From 5 to 10	1,000
Category C....................	From 10 to 15	1,500
Category D....................	From 15 to 20	2,000
Category E....................	From 20 to 30	2,500
Category F....................	More than 30	3,000

2. The inhabitants of any non-self-governing colonies or protectorates of a country may, at the discretion of that country and in accordance with its own census data, be counted with its own inhabitants.

3. No member of the Union may without its own consent be assessed by the Union to provide funds for other than general administrative expenses.

Article V

1. Any member of the Union may withdraw therefrom, provided said member shall have fulfilled all of its current obligations.

2. A member of the Union may be expelled or dropped from membership by a three-fourths vote of the members of the Council, either present or represented, for non-payment of the minimum annual subscription or for a serious offense, the member having previously been called upon to furnish explanations.

Article VI

1. The Union shall be administered by a Council composed of the delegates of the constituent countries, the members and distribution of such delegates to be determined by the categories of Article IV in accordance with the following table:

	Delegates		Delegates
Category A....................	1	Category D....................	4
Category B....................	2	Category E....................	5
Category C....................	3	Category F....................	9

2. These delegates shall be appointed for a term of three years by the "national chemical federation" of the respective countries. One-third of the membership of the Council shall retire annually but the retiring members shall be eligible for re-appointment.

Article VII

1. The executive functions of the Council shall be exercised through a committee of the officers, which shall be a president, four vice-presidents, and a general secretary. These officers shall be elected by the Council from among its own membership by a majority vote. They shall serve for terms of three years and, with the exception of the general secretary, shall not be eligible for immediate re-election to the same office. The president shall be chosen from among the vice-presidents.

Article VIII

1. The Council shall meet at least once a year on the day before the annual general meeting in the town where the latter is to be held, and in addition as often as it shall be convened by its president, or upon the requisition of one-fourth of its members.

---

[1] See CHEM. & MET. ENG., vol. 21, No. 5, Sept. 1, 1919, p. 234.

[2] This is a free and unofficial translation of the French text. A committee was appointed to prepare an authorized English version.

[3] TRANSLATOR'S NOTE.—The purpose of this paragraph is to provide for the formation in each country of some national agency which shall federate all of the major chemical organizations of the country. Thus in the United States this federation is effected through the Chemistry Division of the National Research Council, while in England it is effected through their Federal Council of Chemistry. Ultimately it is expected that in each country the federating agency will become merged in the National Research Council of that country in the capacity of its Chemistry Division.

2. The Council shall fix the date and place of meeting, draw up the budget, and decide as to expenses.

3. Resolutions shall be adopted by a majority.

4. On questions of an administrative or financial nature the voting shall be by countries, each country having a number of votes equal to the number of its delegates. In such voting it is, however, not necessary that all these delegates be present. The delegates of any country may appoint one or several proxies to represent them and to vote in their name.

5. Voting by correspondence is permitted.

6. All questions to be voted upon must appear on the agenda of the meeting.

7. The president shall have the casting vote in case of a tie.

Article IX

1. Minutes shall be kept of all meetings. Two copies of the minutes shall be prepared and signed by the chairman and the secretaries of the meeting.

2. The permanent secretarial staff shall have the custody of the archives, and shall be entrusted with the execution of the decisions taken by the Council and by the committee of officers and in particular with the circulation of the agenda.

Article X

1. The functions of the committee of officers shall be:

(*a*) To see that the rules are strictly observed.

(*b*) To prepare the agenda for meetings of the Council.

(*c*) To record and carry out the decisions of the Council.

(*d*) To perform during the entire period elapsing between two meetings of the Council the necessary acts of administration and to report the same in writing to the members of the Council.

(*e*) To submit to the Council a yearly budget draft.

(*f*) To represent the Union or to appoint its representatives.

Article XI

1. There shall be instituted, in addition to the Council, a consultative committee, consisting of as many sections as shall be necessary to insure the complete representation of pure and applied chemistry in conformity with the regulations of the Union.

Article XII

1. The General Assembly of the Union shall consist of the members of the Council and of the delegates of the "national chemical federation" of the constituent countries.

2. A regular meeting of the General Assembly shall be held at least once a year, preferably at the time and place of the meeting of the International Congress of Pure and Applied Chemistry.

3. The General Assembly shall also meet when called together by the Council or when such meeting is requested by at least one-half of the members of the Union.

4. The General Assembly shall receive reports on the administrative work of the Council, on its financial situation, and on the general condition of the Union.

5. It shall approve the accounts of the previous fiscal year as certified by an auditor, selected from outside the membership of the Council and appointed by the General Assembly of the preceding year.

6. It shall pass upon the budget for the next fiscal year and shall discuss those questions appearing upon its agenda.

7. The annual report and the financial statement shall be sent each year to all the members three months in advance of the annual meeting of the General Assembly. The agenda of the General Assembly shall be drawn up by the Council and must include every question which shall have been transmitted to it by any of the members of the Union three months in advance of the meeting of the General Assembly.

8. The officers and executive committee of the General Assembly shall be identical with those of the Council.

9. Votes on administrative and financial questions shall be cast by countries, each country having the number of votes indicated in the categories of Article VI.

10. The delegates of any country may appoint one or several proxies to represent them and to vote in their name.

Article XIII

1. All expenditures shall be authorized by the president and disbursed through the administrative secretary.

2. The spokesman and representative of the Union before the public and in all legal matters and court proceedings shall be its president, who may, however, delegate his powers in this respect to the administrative secretary or to any member of the Council.

Article XIV

1. Resolutions of the Council relating to such purchases, exchanges and transfer of real property as may be needed for the accomplishment of the objects of the Union, grant of mortgages on the said properties, leases for more than 9 years, transfers of properties and loans, must be submitted to the General Assembly for approval.

Article XV

1. Amendments to these statutes may be considered and voted upon by the General Assembly only when submitted thereto by the Council of the Union or proposed by a "national chemical federation" of one of its constituent countries. All such proposed amendments shall appear upon the agenda of the meeting of the General Assembly, provided they have been received in writing by the committee of officers at least three months in advance of the meeting.

2. Voting upon amendments shall be by countries in accordance with the categories of Article VI.

3. Voting by correspondence is permitted.

4. The statutes may be amended only by a two-thirds majority of the votes cast.

Article XVI

1. In the event of a meeting of the General Assembly being convened to decide upon the dissolution of the Union, special notices to that effect shall be sent three months in advance; and at least three-quarters of the members of the Union or their proxies must be present. If this proportion is not reached, the General Assembly shall be adjourned for not less than six months, when the decision of the adjourned meeting shall be operative, irrespective of the number of members present.

In any case, dissolution can only be resolved upon by a majority of two-thirds of the votes cast.

Article XVII

1. In the event of dissolution the General Assembly shall appoint one or more trustees to liquidate the property of the Union; and any surplus assets shall be donated to an international institution.

Article XVIII

1. In the interpretation of these statutes the French text shall be authoritative.

Eighth Annual Safety Congress

THE National Safety Council will hold its Eighth Annual Safety Congress at the Hotel Statler, Cleveland, Oct. 1 to 4, 1919. During the week of the Congress, the people of Cleveland will endeavor to excel the record established by St. Louis in its "Safety Week" last year. They have undertaken a difficult task, for the achievement of St. Louis was remarkable. In that city during Safety Week there was only one death from accident (an intoxicated man killed in falling from a wagon), whereas during the previous week there were ten accidental deaths and during the corresponding week of the previous year there were twenty-four. But the enterprising spirit of Cleveland recognizes no limitations in a great humanitarian work of this kind. Every man, woman and child in the city will be on the alert to prevent accidental injuries during the special campaign. Every factory, every school, every home, all the educational and social forces in the entire community will be enlisted in one great life-saving effort. The goal is *no accident* during Congress week. A large clock on the Cleveland Trust Co. building near the Hotel Statler will register the record each day.

TIME-TABLE OF MEETINGS

Sessions	Wednesday Oct. 1	Thursday Oct. 2	Friday Oct. 3	Saturday Oct. 4
Registration	9: a.m.			
Annual Meeting of Members	10:00 a.m.			
Directors' Meeting	5:00 p.m.			
Executive Committee Meeting		5:00 p.m.		
Reception and Informal Dance	9:00 p.m.			
Informal Dinner and Smoker		7:00 p.m.		
Banquet (Informal)			7:00 p.m.	
GENERAL SESSIONS:				
Employees' Representation	2:00 p.m.			
Americanization		2:00 p.m.		
Health			2:00 p.m.	
Safety Education				2:00 p.m.
ROUND-TABLES:				
General Round-Table		8:00 a.m.		
A,B,C, Session		9:30 a.m.		
Employees' Benefit Associations			9:30 a.m.	9:30 a.m.
Employees' Publications		12:30 p.m.		
Bulletins			12:30 p.m.	
SECTIONAL MEETINGS:				
Automotive		9:30 a.m.	9:30 a.m.	
Cement		9:30 a.m.	9:30 a.m.	
Chemical		9:30 a.m.	9:30 a.m.	
Construction		9:30 a.m.	9:30 a.m.	
Electric Railway		9:30 a.m.	9:30 a.m.	
Health Service			9:30 a.m.	9:30 a.m.
Local Council Officers			9:30 a.m.	9:30 a.m.
Marine and Navigation				9:30 a.m.
Metals		9:30 a.m.	9:30 a.m.	9:30 a.m.
Mining		9:30 a.m.	9:30 a.m.	9:30 a.m.
Packers		9:30 a.m.	9:30 a.m.	
Paper and Pulp		9:30 a.m.	9:30 a.m.	
Public Safety			9:30 a.m.	9:30 a.m.
Public Utilities			9:30 a.m.	9:30 a.m.
Rubber				9:30 a.m.
Steam Railroad		9:30 a.m.	9:30 a.m.	9:30 a.m.
Textile		9:30 a.m.		
Women in Industry		9:30 a.m.	9:30 a.m.	
Wood-working			9:30 a.m.	9:30 a.m.

EXHIBIT—Opens Monday, Sept. 29, 8:00 p.m. Open daily 11:00 a.m. to 11:00 p.m. Grays' Armory. Closes Saturday 6:00 p.m.

The following papers will be presented at the sessions of the Chemical Section, of which E. H. Fiesinger, safety engineer, Solvay Process Co., is chairman:

THURSDAY MORNING

9:30—"Supervision of the Chemical Industry From the Point of View of Accidents and Occupational Diseases," Dr. Alice Hamilton, United States Bureau of Labor Statistics, Washington, D. C.

10:15—"Lead Poisoning and Its Prevention," C. P. Tolman, chairman manufacturing committee, National Lead Co., New York City.

11—"Dangers in the Manufacture of Dyes," Dr. L. C. Cone, National Aniline & Chemical Co., Buffalo, N. Y.

FRIDAY MORNING

9:30—"The Controlling Factors in Gas Mask Design," Dr. W. K. Lewis, Massachusetts Institute of Technology, Cambridge, Mass.

10:15—"Some Experience in Accident Prevention in the Dye Industry," A. H. Massey, E. I. du Pont de Nemours & Co., Wilmington, Del.

11—"The Failure of Materials Due to Chemical Action," E. G. Rippel, sales manager Buffalo Foundry & Machinery Co., Buffalo, N. Y.

The Metals Section will hold three sessions, at which the following papers will be read:

THURSDAY MORNING

9:30—"Accident Prevention in a Malleable Iron Foundry," H. L. Church, Rockford Malleable Iron Works, Rockford, Ill.

10:15—"The Personal Element in a Safety Program for the Foundry," M. F. Gartland, Marion Gray Iron Foundry Co., Marion, Ind.

11—"Safety in the Steel Foundry."

FRIDAY MORNING

9:30—"Consider the Crane," C. C. Rausch, assistant director Safety Institute of America, New York City. Discussion by O. J. Lewis, McKinney Steel Co., Cleveland, Ohio.

10:15—"New Ways to Put Safety Across in a Steel Plant," H. P. Weyne, United Alloy Steel Corporation, Canton, Ohio. Discussion by H. W. Darr, Cambria Steel Co., Johnstown, Pa.

11—"Practical Demonstration of Investigating Accidents," court of inquiry staged by H. J. Weeks with employees of American Steel & Wire Co.

SATURDAY MORNING

9:30—"How the Foremen Cut Lost Time Accidents," James F. Belford, acting secretary of labor, safety and welfare, American Smelting & Refining Co., New York City. Discussion by E. E. Judd, American Smelting & Refining Co., Omaha, Neb.

10:15—"Humanizing a Steel Plant," Philip Stremmel, superintendent hot mills, National Enameling & Stamping Co., Granite City, Ill. Discussion by Raymond G. Adair, safety engineer, American Rolling Mills Co., Middletown, Ohio.

11—"Practical Demonstration of Welding and Cutting," J. Schleicher, the Alexander Milburn Co., Baltimore, Md. (All present to have welding goggles furnished by various manufacturers.)

The Safety Exhibit to be shown at Grays' Armory will be unquestionably the most pretentious and elaborate ever shown in America. Practically all of the leading manufacturers of safety devices will be represented. This feature of the Congress will be presented under the joint auspices of the National Safety Council and the Safety Institute of America.

The exhibit will be opened at 8 o'clock, Monday evening, Sept. 29, and will be open thereafter between 11 a. m. and 11 p. m. daily. It will close Saturday, Oct. 4, at 6 p. m.

The exhibit will be open free to the public. Workingmen and their families are especially invited to view the exhibits in the evening of any day during Congress week.

Chicago Exposition and Conventions

EVERY available space was filled in the great Coliseum, in which the Chemical Exposition was held in Chicago. The first impression on looking down from the gallery was that the main floor exhibits were divided into three sections by aisles.

The combined exhibit along the center aisle made by the General Chemical Co., the Barrett Co., the Semet-Solvay Co. and the National Aniline & Chemical Co. struck a new note in technical exhibitions by calling in the art of the architect in structural design and interior decoration and that of the artist in paint. Every detail was worked out with artistic feeling and understanding and the insignia of the Chemical Warfare Service were used with charming effect. The services of Arthur Covey, a sound painter, were availed of, and along the walls we found very decorative panels of the interior of a dye house and of a synthetic color works. A picture of Herreshoff furnaces in operation with heaps of Spanish pyrites to balance the composition in general challenged the eye to closer inspection, and it did all this unconsciously. Art pays.

THE OFFICIAL OPENING

It is curious how we are tied to conventions. In olden days when royalty visited a city the Mayor appeared in his robes of office and welcomed their Highnesses, pledging the constant devotion of the people, then serenity would respond in appreciation. When we have a convention or exposition nowadays we go through a similar performance. It is doubtful if the good people of Chicago were anxious to show their Mayor, and consequently on the opening of the Exposition the Governor of Illinois was to have made the address of welcome and our colleague, Dr. C. H. Herty, editor of the *Journal of Industrial and Engineering Chemistry*, was to have responded, but the one was in Washington and the other in Europe, so Chairman Redman of the Chicago Section bade all welcome and Manager Roth responded with felicity.

EXHIBITS OF SMALL-SCALE APPARATUS A FEATURE

The miniature and small-scale apparatus shown are features of the exposition. The Raymond Impact Pulverizer Co. had mills of several sizes in operation, the Dorr Co. showed its thickener and the General Bakelite Co. had a molding machine for making pressed beakers of Bakelite, the Redmanol Chemical Products Co. did similar work with Redmanol, making cigar and cigarette holders. The Industrial Filtration Corp. showed a rotary vacuum filter with which they separated diatomaceous earth. Other small units in operation included a Jewell still, a Proctor cotton drier and exhibit of the Philadelphia Drying Machine Co. Maurice A. Knight of Akron showed in operation a miniature acid pumping system that occupied hardly more than one cubic foot of space and the General Ceramics Co. exhibited a complete nitric acid plant in miniature but not operating.

INDUSTRIAL CHARTS

Making charts has become not only an art but a fashion. The coal tar chart of the Barrett Co. was considerably amplified over that of last year. The U. S. Industrial Alcohol Co. showed another of alcohol and the American Cyanamid Co. exhibited its raw materials and all products in sequence. The Hooker Electrochemical Co. began with salt and water which it treats with electricity derived from Niagara Falls power and showed all its products. The Technical Association of the Pulp and Paper Industry gave a similar graphic representation of the making of paper. The New Jersey Zinc Co. exhibited Franklin ore and the various steps in making each product, ending with white rubber goods and objects in brass and zinc.

Not exactly in the form of a chart but nevertheless well displayed were the products of Shawinigan Falls, Quebec: Calcium carbide, acetylene, acetaldehyde, and acetic acid. In the same booth the Shawinigan Electro Metals Co. had an exhibit of magnesium and its uses, particularly as a deoxidizing agent as an alloy with aluminum to improve its strength, density, machining qualities, finish and polish.

MINING ENGINEERS

The first day of the meeting of the Institute was marked by a large registration and several technical sessions. The boat trip scheduled for Gary, Indiana, was definitely postponed on account of the steel strike and arrangements were made to hold the meetings in Chicago. The smoker on Monday evening was one of the best affairs of its kind ever held. George H. Rice, chief mining engineer of the Bureau of Mines, and Dr. F. G. Cottrell, assistant director, both of whom have recently returned from France, gave illustrated talks of their trip.

CHICAGO A BUSY HOST

The prospects for successful meetings of five of the leading American scientific and technical societies are excellent in spite of the unsettled industrial conditions. Chicago never before entertained so many scientific and engineering bodies in one week, and while it afforded an unusual opportunity for meeting men from all parts of the country the general consensus was that there was an undesirable congestion of such functions that should be avoided in the future if possible.

Borax in Searles Lake Potash

Investigation by the Department of Agriculture, it is stated officially, has developed that the potash put on the market by one of the companies operating on Searles Lake contained an injurious amount of borax. The investigation has not proceeded far enough to determine the character of the output of others operating in the same area. The salts which were examined showed an average of 10 per cent borax. Some samples went as high as 23 per cent borax, the Department states. The Bureau of Soils is in receipt of numerous complaints of crop injury resulting from the use of Searles Lake potash. The Bureau has satisfied itself that injury to crops will result when a sufficient amount of borax is applied with the potash.

Research Problems Before the Bureau of Standards

A total of $440,000 for research work and materials is carried in the first deficiency appropriation bill, which just has been taken up by the House of Representatives. Industrial research calls for $250,000 of the appropriation; testing government materials, $100,000; industrial safety standards, $25,000; standardization of instruments, $50,000, and the purchase of platinum for laboratory use, $15,000. The money is to be expended by the Bureau of Standards.

International Exposition of Mining Industries

The permanent exhibit of mining and metallurgical machinery planned by the Merchants and Manufacturers Exchange of New York[1] will open on Dec. 1, at Grand Central Palace.

One entire floor will be devoted to machinery, appliances, supplies and products pertaining to metal mining, non-metal mining, coal mining and the production of petroleum. Other floors will be devoted to other permanent expositions and exchanges of interest to engineers, such as material handling machinery, general machinery, factory appliances, municipal equipment and farm tractors and implements. Mr. Howard R. Ward, manager of the Exposition, who has recently returned from a trip through the West, reports widespread interest on the part of manufacturers and engineers interviewed. Some are especially attracted by the possibility of opening up business in foreign countries, some are considering it from a purely advertising standpoint, while others are planning to use the Exposition as their Eastern office or as an adjunct to their New York office.

The value of this centralized Exposition is readily appreciated. To the buyer it will be a center where he can accomplish the bulk of his purchasing in a short space of time, without traveling all over the country. To the manufacturer it will be a point of contact with the buyer. To the engineer it will be a center where he not only can study "standard practice" but will be able to see new devices and methods. New York is the logical point to which operators and engineers come to interest capital. Grand Central Palace will become the most convenient central point to which engineers, mine operators and purchasers will bring those whom they wish to interest financially.

New Headquarters for A. S. T. M.

The executive committee of the American Society for Testing Materials announces that the establishment of headquarters in the building of the Engineers' Club of Philadelphia, 1315-17 Spruce Street, forecast in its annual report to the Society, is now assured. It had become increasingly evident during the past year that the growing activities of the Society required an expansion which is not possible at the University of Pennsylvania, where the headquarters have been maintained under most pleasant and advantageous conditions since the incorporation of the Society in 1902.

The headquarters will be on the third floor of the building, where extensive alterations are now being made which will enable the Society to maintain very suitable headquarters.

The new headquarters are centrally located and convenient to the principal hotels and railway stations. The Engineers' Club is affiliated with the Philadelphia sections of many of the national engineering and technical societies, and is the center of engineering activities in Philadelphia. An auditorium on the second floor of the building, with a seating capacity of 125, and a committee room in the Society's headquarters will offer very satisfactory facilities for meetings of the committees of the Society. Out of town members may use the Society's headquarters as their mailing address while in Philadelphia, and facilities will be provided in the Society's rooms for correspondence.

Bill Providing for Research on Oil Shales

Convincing reasons why the Bureau of Mines should undertake experiments looking to the commercial development of petroleum from oil shale have been presented to the Senate Committee on Mines and Mining. The committee recently took up the consideration of a bill by Senator Henderson of Nevada providing $140,000 for such an investigation. The committee referred the bill to the Secretary of the Interior for his report. Mr. Lane submitted a lengthy review on the oil shale situation which he closed as follows:

"Experimental work must necessarily precede such a large undertaking as the development of the oil shale industry, and I recommend that such work start now so that at the time when the supply of petroleum from our wells does not meet the essential demands, then the oil from shale will be ready to alleviate partially this shortage. Favorable action by Congress upon such a measure as S. 2671 will help to bring about the desired results."

Civil Service Examinations

The following examinations are announced:

Metallurgist.—Vacancies exist in the Ordnance Department at Large for duty at manufacturing plants within the United States, at $3400 to $3600 a year. Closes Oct. 7, 1919.

Research Operator-Metallurgical.—The register of eligibles will be divided into two grades, Grade I, $1500 to $2000 a year, and Grade II, $2000 to $2500 a year. After six months' satisfactory service in Grade II, appointees will be eligible for promotion to Grade III, in which the salaries range from $2500 to $3000 a year. The duties of these positions consist of work in connection with research projects, either ferrous or non-ferrous, on ordnance materials. Although originally announced for Aug. 12, it is understood that it will be re-opened for another sixty days.

Physicist, Qualified in Optics.—The duties will consist of the supervision of the work of the optical division of the Bureau of Standards. Salary, $3600 to $4000. Oct. 14, 1919.

Minerals Relief Commission Resumes Work on Claims

The Shafroth Commission has returned from a visit to twelve cities, during which testimony was taken in 500 cases. The Commission came back with a clearer understanding of the situation and is prepared to dispose of claims rapidly from this time on. It is admitted by the Commission that the limitations of the act work injustices in numerous cases, and it is probable that the Commission will be requested, in the light of its experience, to suggest amendments to the act which will make it more equitable. Nevertheless, the Commission will dispose as rapidly as possible of the claims which clearly fall under the act as it now stands, allowing the other claims to await possible legislation looking to changes and liberalization of the law.

The National Pyrites & Copper Co. of Georgia has been awarded $37,000 in full payment of its claim. The company asked $189,723.43. This is the second award to be made, the first being that of the Chestatee Pyrites & Chemical Co., which was given $219,607.90. The company claimed $914,172.73. A third decision denied the claim of J. N. Lotspeich of Morristown, Tenn., who asked reimbursement for expenditures made in efforts to interest capital in certain manganese properties.

---

[1] See CHEM. & MET. ENG., vol. 21, p. 121, Aug. 1, 1919.

Meeting of the Rubber Division, American Chemical Society*

By Andrew H. King

THE recent meeting of the Rubber Division of the American Chemical Society in Philadelphia was a decided success. More than 150 rubber chemists from different sections of the United States and Canada were present. An excellent program was given. The following is an effort to sum up in a few words the trend of the respective papers:

Report of Fruit Jar Ring Committee, L. J. PLUMB, chairman.—At the previous meeting of the old Rubber Section the seriousness of the fruit jar ring situation was ably pointed out. As a result this committee was appointed to take steps to secure satisfactory jar rings for the American housewife. Through their efforts and those of the Department of Agriculture the jar manufacturers have ceased putting poor rings in jars, and have secured the co-operation of ring manufacturers in producing only high-grade articles. Inasmuch as the Department of Agriculture has a large number of demonstrators at work, all of whom have been instructed to help educate the public to accept only good rings, the committee did not feel that further work on its part was necessary, and asked to be discharged, which was done.

Report of Committee on Physical Testing, H. E. SIMMONS, chairman.—The committee has prepared a tentative scheme for physical testing. A most pleasing feature of the report was the fact that the metric system was used throughout. Its decided advantage over the English system of units is well known. The time saved and the increased accuracy due to its simplicity make it by far the most efficient. We understand that it has been in use for two years at the Goodyear Tire & Rubber Co. in Akron, Ohio. Most of the tests advanced have been in use for some time. The committee tried only to correlate the best procedure in each case. A new method for permanent set was advanced and the arguments in favor of it were presented by E. L. DAVIES of the committee. The test recommended consists of three stretches to 60 per cent of the breaking elongation, held each time for 10 min. with a 10-min. interval between stretches and measuring 10 min. after release. Mr. Davies pointed out that 60 per cent of the breaking elongation is the most satisfactory, since over this figure, tearing becomes a serious factor. He also showed that the set developed on one stretch did not consist of any constant fraction of the total set obtainable and that three stretches bring out practically all the set possible. Set, he explained, is probably due to plastic flow in the rubber.

A New Method for the Determination of Sulphur in Rubber Mixtures, G. D. KRATZ, A. H. FLOWER and COLE COOLIDGE.—The new method recommended did not differ greatly from the old arsenious acid method except that zinc oxide was added instead of arsenious acid to raise the boiling point of the solution. The method was stated to be very rapid and also of a high degree of accuracy.

The Extraction of Rubber Goods, S. W. EPSTEIN and B. L. GONYO.—The authors used constant boiling point mixtures of acetone and carbon bisulphide and acetone and chloroform. They recommended the use of the mixed solvent as a time saver to take the place of separate extractions by acetone and chloroform. Inasmuch as these extractions give valuable qualitative information, as for example, a fluorescent chloroform extract indicates MR or related hydrocarbons, it is not likely that the old method will be dropped for some time.

Theory of Balloon Fabric Protection, JOHN B. TUTTLE.—The author discussed the requirements balloon fabric must meet, the most important of which are low permeability to hydrogen, good aging and low visibility. He mentioned iron oxide as a good pigment for protection.

Balloon Seam Construction, J. W. EVANS.—Mr. Evans pointed out that the temperature inside the bag is 20 to 25 deg. F. higher than on the outside. The application of powdered aluminum as a reflector lowers the temperature on the inside by about 10 deg. F. He found that the high temperature was the cause of slippage at the seams. The most satisfactory cement was found to be a pure gum vulcanized by a dilute solution of sulphur chloride in carbon tetrachloride and benzol.

Expansion of Rubber Compounds, C. W. SANDERSON.—The author reported the cubic coefficient of expansion of brown crêpe as 4.68×10^{-4} per deg. F. Fine Para has about half this value. It was pointed out that milling has a marked effect on the expansion coefficient. The expansion of compounded stocks is almost entirely due to the rubber present. When rubber is heated at a constant temperature the expansion curve (expansion vs. time) shows a rapid rise to a flat, beyond which there is no further increase.

He also pointed out that the specific gravity of a stock increases when it is vulcanized under hydraulic pressure. The difference in gravity between raw and cured stock is probably due to contained air, which is either forced out or greatly compressed by the pressure employed. The contraction noticed for solid tires he placed at about 3 per cent.

Volume Increase of Compounded Rubber Under Strain, H. F. SCHIPPEL.—This paper was perhaps the most interesting of all those presented. The author pointed out an entirely new fact, that compounded rubber increases in volume when placed under strain. This increase was found to be quite high. Values as high as 120 per cent were obtained with whiting. Gas black and zinc oxide when compounded volume for volume against barytes showed much lower increase, due probably to adhesion of the filler to the rubber. Pure gum shows this phenomenon only very slightly. A series of experiments with barytes elutriated to several different sizes showed that the increase in volume was a direct function of the size of the particle. Mr. Schippel closed his paper with a very pretty experiment. A ring of about 2-in. diameter (internal) was stretched over a lump of paraffine. The specific gravity of the aggregate was very close to 1, and the block barely floated. When the ring was secured on the small end of the lump of paraffine without stretching, the paraffine and ring settled slowly to the bottom, thus proving beyond a doubt that the stock in question had a lower specific gravity when stretched.

The Determination of Cellulose in Rubber Goods, S. W. EPSTEIN and R. L. MOORE.—The method which was given in detail consists essentially of dissolving the rubber in cresol, filtering through a Gooch, washing well with benzene and then several times with hot 10 per cent hydrochloric acid until no further soluble matter is removed. The crucible and contents are dried and weighed. The next step is acetylation with acetic anhydride, after which the cellulose acetate is removed by washing with acetone. Cellulose is determined by difference.

---

* Annual meeting, Philadelphia, Sept. 4 and 5, 1919.

The Variability of Crude Rubber, JOHN B. TUTTLE.—This paper consisted chiefly of a résumé of previous work by Eaton and Granthan, de Vries and others. This is a subject on which not a great deal of work has been done in this country.

The Action of Accelerators During Vulcanization, J. H. SCOTT.—Detailed experiments by Spence and the author were described. These consisted of the introduction as dry powder of various alkaline substances, such as NaOH, Na_2CO_3, $Ba(OH)_2$, soda lime and MgO; dipping in alkaline solutions; and the washing of rubber with caustic.

Considerable reduction in the period of vulcanization was shown by all alkalis tried. Zinc oxide was found to be an aid, while barytes was without effect. In addition the physical properties of the stocks were improved. Washing with alkali gave slightly improved physical properties but no decrease in time of vulcanization. Immersion in 5 per cent NaOH solution for 24 hr. produced a slightly shorter cure with a little higher tensile strength.

The author pointed out that alkalis are not satisfactory accelerators, due probably to the bad aging properties of the compounds. The fact that they are accelerators is of considerable theoretical interest. They probably function by the hydrolysis of the nitrogenous matter of crude rubber to amino acids, which are powerful accelerators, comparing favorably with piperidine.

Mr. Scott defined the ideal accelerator as one capable of bringing about vulcanization in the shortest possible time consistent with factory practice and which produces maximum polymerization. It should also be nonpoisonous and easily handled. For some time it has been recognized by rubber chemists that accelerators have another effect than merely decreasing time of cure. The increase in tensile strength, snap, feel and nerve the author attributes largely to polymerization.

The Action of Certain Organic Accelerators in the Vulcanization of Rubber, G. D. KRATZ, A. H. FLOWER and COLE COOLIDGE.—This paper consisted of a review of experiments with aniline, urea, thiourea, mono-, di- and tri-phenyl thiourea and mono-, di- and tri-phenyl guanidine, anhydro formaldehyde aniline and paraphenylene diamine. The authors attribute the curing power of these accelerators to their decomposition at the temperature of vulcanization in the presence of sulphur-giving aniline, which they claim has a grouping which readily functions as a sulphur carrier. They recommend comparing accelerators in molecular quantities.

Reactions of Accelerators During Vulcanization, C. W. BEDFORD and WINFIELD SCOTT.—This paper is a reply to and a criticism of a recent paper by Dubosc in the *India Rubber World.* The authors stated that hexamethylene tetramine decomposes when heated with sulphur at the curing temperature and gives off CS_2, NH_3 and H_2S, but no acetylene, as claimed by Dubosc. They also stated that methylene aniline decomposes when heated under similar conditions, giving CS_2, aniline and thiocarbanilide.

The Effect of Organic Accelerators on the Vulcanization Coefficient, D. F. CRANOR.—The author gave in detail the results of experiments with hexamethylene-tetramine and the addition product similar to thiocarbanilide produced by the action of CS_2 on dimethylamine. He showed that the coefficient of vulcanization bears no direct relation to the physical properties. He obtained a technical cure with the dimethylamine addition product when the coefficient of vulcanization was aproximately 1.00. This falls in line with Scott's statement regarding the polymerizing influence of accelerators. Dimethylamine-dimethyl-dithiocarbamate is an extremely powerful accelerator. One-half per cent brings about a cure in 5 min. at 40 lb. steam.

Some Methods of Testing the Hardness of Vulcanized Rubber, H. P. GURNEY.—This paper consisted of a review of the different methods of determining hardness of rubber goods and contained data on the Shore hardometer and the Pussey-Jones plastometer.

The Manufacture and Use of Crimson Antimony, J. M. BIERER.—The author gave a detailed description of the preparation of crimson antimony, i.e., antimony oxysulphide. The important points on the preparation are purely of antimony trichloride solution, and the concentration of the acid used for precipitation.

Research on Zinc Products for the Rubber Industry, P. R. CROLL and I. R. RUBY.—It was pointed out that the New Jersey Zinc Co. is very desirous of improving the quality of its zinc oxide for the rubber industry and has installed a rubber division in its new research laboratory for this purpose. Lantern slides showing the ultimate particles of zinc oxide were exhibited. Zinc oxide is crystalline and the particles vary in size from 0.1 to 1 micron, the average being 0.5 micron. Their microscopic work is excellent and is fundamental to an understanding of compounding phenomena.

Carbon Black—Its Properties and Uses, ST. J. PERROTT.—This paper was delivered in the Division of Industrial Chemists and Chemical Engineers and proved so interesting that Chairman Tuttle invited Mr. Perrott to give it also before the rubber division. The manner of producing gas black by incomplete combustion of natural gas, allowing the smoky flame to strike a cold metal surface (air cooled) was illustrated by lantern slides. From the black cloud issuing above the plant shown, one would gather that technique of this industry is not very highly developed. Mr. Perrott showed several slides of micro-photographs of gas black and stated that the particles varied in size from 30 to 100 milli-microns.

The paper of H. E. SIMMONS on the value of a library to the rubber laboratory was not given, but will be published soon. Owing to the absence of GEORGE OENSLAGER his paper on the testing of pigments was held over until the next meeting of the Rubber Division. The paper of C. OLIN NORTH on the effect of compounding ingredients on the physical properties of rubber was unfortunately not in final shape for presentation, but will doubtless be given at the next meeting of the division.

ELECTION OF OFFICERS

The officers elected for the coming year are Dr. WARREN K. LEWIS, chairman; and ARNOLD H. SMITH, secretary. Dr. Lewis is a well known member of the chemical engineering staff of Massachusetts Institute of Technology and has been acting as consulting engineer to the Goodyear Tire & Rubber Co. for several years. The Rubber Division is fortunate in securing the services of Dr. Lewis, who is widely known because of his ability to "start something." Mr. Smith is the efficient secretary who served the Rubber Division so well this year.

A rising vote of thanks was tendered the retiring chairman, Mr. Tuttle, who has perhaps had more to do with the organization of the Rubber Division than any other rubber chemist, and to whose untiring efforts, with those of Mr. Smith, the success of the recent meeting was largely due.

The success of the Rubber Division is now assured. As was pointed out by Dr. CHARLES L. PARSONS in a brief talk, it was only necessary that the rubber chemists should meet and get acquainted, when they would cease being suspicious of one another and would jump in and make the thing a success. It augurs well for the rubber industry.

Iron and Steel Output

The London *Economist* of May 31, 1919, gives the following figures for the iron and steel output of the chief producing countries before and during the war:

PIG IRON

Year	United Kingdom (Long Tons)	United States (Long Tons)	Germany (Metric Tons)	France (Met. Tons)
1900	8,960,000	13,789,000	8,521,000	2,714,000
1905	9,608,000	22,992,000	10,988,000	3,077,000
1910	10,012,000	27,304,000	14,793,000	4,032,000
1911	9,526,000	23,650,000	15,534,000	4,939,000
1912	8,751,000	29,727,000	17,753,000	4,939,000
1913	10,260,000	30,966,000	19,292,000	5,207,000
1914	9,924,000	23,332,000	14,392,000	†
1915	8,794,000	29,916,000	11,790,000	†
1916	9,048,000	39,435,000	13,285,000	1,447,000
1917	9,420,000	38,621,000	13,142,000	1,684,000
1918	9,066,000	39,052,000	*11,590,000	1,297,000
		STEEL		
1900	4,901,000	10,188,000	6,646,000	1,565,000
1905	5,812,000	20,024,000	10,067,000	2,240,000
1910	6,374,000	26,095,000	13,699,000	3,390,000
1911	6,462,000	23,676,000	15,019,000	3,681,000
1912	6,796,000	31,251,000	17,302,000	4,428,000
1913	7,664,000	31,301,000	18,959,000	4,687,000
1914	7,835,000	23,513,000	14,973,000	†
1915	‡8,550,000	32,151,000	13,258,000	†
1916	‡9,196,000	42,774,000	16,183,000	1,952,000
1917	‡9,804,000	45,061,000	16,587,000	2,232,000
1918	‡9,591,000	45,073,000	*14,874,000	1,912,000

* Including Luxembourg up to October, 1918. The returns for November and December, 1918, do not include the production of Luxembourg, Saar district and the disannexed Lorraine Province.

† No returns.

‡ Including steel castings.

United States Platinum Corporation Proposed

A concern to be known as the United States Platinum Corporation, to be chartered by Congress and to be supervised by a Government commission of five members, is proposed in a bill introduced by Representative O'Connell of New York. The operations of the company are to be confined to the public domain in Alaska. A royalty of one-eighth of the net products obtained from platinum sands is to be paid to the Government. L. R. Beckley and unnamed associates are the incorporators of the proposed corporation.

German Production of Fertilizers

According to the *Deutsche Allgemeine Zeitung*, the production of certain fertilizers in Germany during 1913-14, 1917-18, and 1918-19, was:

Articles	1913-14 Tons	1917-18 Tons	1918-19 Tons
Nitrogen	210,000	92,334	80,000
Phosphoric acid	530,000	325,000	220,000
Potash	557,350	779,400	520,000

Engineering Council Addresses the President Regarding United States Maps

Engineering Council, through its chairman, J. Parke Channing, has brought to the attention of the President the lack of co-ordination among the official map-making agencies of the Government. Setting forth the fact that every industry, art and science which demands a knowledge of the lay of the land is dependent upon suitable maps, and emphasizing the value of co-ordinating governmental efforts on the making of a base map of suitable accuracy and scale, Mr. Channing called to the attention of the President the fact that the official map work of the United States is now being prosecuted by 12 separate and distinct Federal agencies. Most of these agencies are making maps for special purposes, which are of little value for any other purpose. The amount of money now being expended would, if covered into a well-co-ordinated mapping plan, produce better and more useful results than that which now can be shown by the aggregate production of all Government map-making agencies. A portion of the argument presented follows:

"Engineering Council believes that the chaotic condition above described is wrong. It makes this presentation to the Executive because he is the one authority having jurisdiction over all of the Federal agencies above mentioned. It is the opinion of Council that the most purposeful way to bring order into map making and to expedite the completion of our topographic map is to appoint a Board of Surveys and Maps consisting of a representative from each of the present Federal map-making agencies, together with representatives from well-qualified map-using agencies, which would be vested with authority to work out a plan of standardization and co-ordination of the work of the Government, and to report the same to the President for such action as he may find wise.

"In order to give further definition to the present petition and to facilitate your consideration thereof, Engineering Council suggests the following unofficial bodies as the proper ones to participate in the work of the Board: The American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Association of State Geologists, the National Research Council, the American Association of State Highway Officials and the Engineering Council."

Government Disposes of Surplus Phenol

Thirty million pounds of phenol, the entire surplus stock of the War Department, has been sold to the Monsanto Chemical Works of St. Louis and New York. The Monsanto company has agreed to resell this phenol at prices to be fixed by the War Department, but is to receive a 2 per cent commission to cover the expenses of selling. The chemical company agrees to dispose of the phenol within four years or less, or at the end of the four years to purchase any remainder at such a price as arbitrators may designate. An officer of the Ordnance Department will be assigned to the Monsanto Works to represent the Government in the carrying out of the contract. Preference is to be given to purchasers who intend using the phenol for consumption in the United States. No orders for less than a carload lot will be considered.

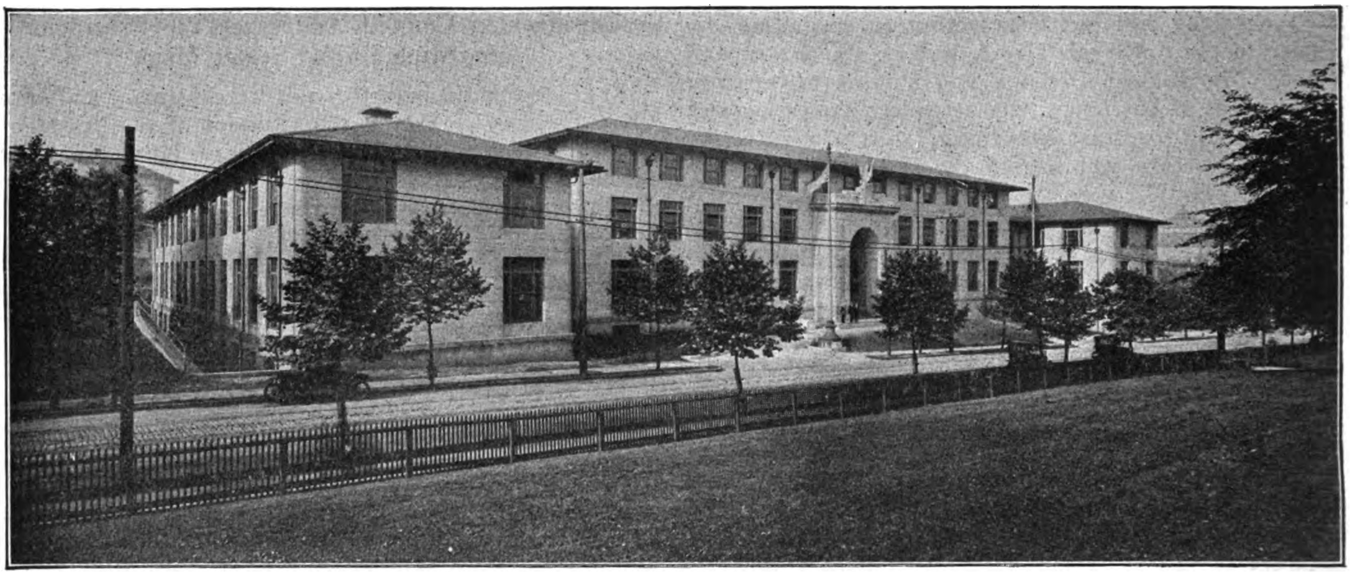


FIG. 1. FRONT VIEW OF PITTSBURGH LABORATORIES, BUREAU OF MINES

Description and Activities of the Pittsburgh Station, Bureau of Mines

A New Laboratory Building Costing About One Million Dollars Has Been Dedicated to the Service of the Public at Pittsburgh by the Bureau of Mines — Its Activities Cover a Wide Range of Subjects of Importance to Chemical and Metallurgical Enterprise

BY E. E. THUM

DEDICATION of the new Pittsburgh Station of the Bureau of Mines, Sept. 29, was an important milestone in the development not only of this particular station, but of the Bureau as well. Coming at a time when the activities lately so engrossed with war problems are being returned to their normal channels, the provision of such extraordinary experimental facilities promises an equally wide range of future usefulness.

DEVELOPMENT OF STATION ACTIVITIES

Activities such as are now centered in this new station were begun in Pittsburgh in 1908, before the Federal Bureau of Mines was established. This early work was a continuation of the investigative work on coals begun at the St. Louis Exposition, 1904, under the U. S. Geological Survey, the lamented Joseph A. Holmes being chief technologist in charge. A nucleus of instrumental equipment from that World's Fair was installed in the old Butler Street arsenal by arrangement with the War Department. Directed first to the investigation of coal mining problems and of fuels, the chief motive was a desire to guard the miner from the risks incident to his occupation. At the time of the passage of the act establishing the bureau (1910), the factors most effective in calling attention to the need of governmental action were several frightful mining disasters in December, 1907, and a growing realization of the preventable waste of life and resources in the mining and metallurgical industries, later culminating in the "Safety First" movement.

Therefore the statute creating the Bureau of Mines of the Interior Department authorized the new organization to investigate methods to increase health, safety and efficiency in the mineral industries, which being widely interpreted means that the Bureau is enabled to act in many directions all centering upon the conservation of life, material and resources in mining, quarrying, ceramic and metallurgical industry. Having no police powers, the Bureau must translate its findings to practice thorough education, and by co-operation with private corporations or public institutions. With such a wide field of activity, it is also natural that work be segregated at various points geographically well situated with respect to each particular subdivision. Therefore, aside from the general administrative offices at Washington, and important specialized activities at other points, the so-called "stations" of the Bureau now number eleven, as given in the table.

While it is not the present purpose to discuss the work of the Bureau as a whole, the Pittsburgh station is of general interest in that it may be regarded as the parent station, being the headquarters of the Supervisor of Stations, Dr. Dorsey A. Lyon, and having many facilities serving all stations in common. Such a central clearing house is obviously necessary in order to insure the most effective action of all branches among themselves and with the various State agencies working along similar lines, to harmonize activities and avoid needless duplication of effort. Again, although the principal work of the Pittsburgh Station has to do with coal mining, several other cognate divisions are

STATIONS OF THE BUREAU OF MINES
Dr. Dorsey A. Lyon, Supervisor of Stations

Superintendent	Name of Station and Location	Date of Establishment	Scope of Major Investigations	Principal Co-operating Institutions
E. A. Holbrook	Joseph A. Holmes Memorial Station at Pittsburgh, Pa.	1908	Coal mining in all its phases, including mine safety, first-aid, and mine rescue work, testing of explosives also metallurgy of iron and steel.	
C. A. Herbert (acting)	Middle-West Station at ~~Urbana~~, Ill.	1908	Coals of the Middle-West fields, and general coal preparation.	University of Illinois. Illinois Geological Survey.
Thos. Varley	Inter-Mountain Station at Salt Lake City, Utah.	1910	Complex and low grade ores, especially those of zinc and lead. Concentration problems.	University of Utah.
R. B. Moore	Rocky Mountain Station at Golden, Colo.	1910	Rare metals especially. Problems connected with the mining and metallurgical treatment of other ores commonly found in Colorado.	State School of Mines.
L. H. Duschak	Pacific Station at Berkeley, Cal.....	1911	Metallurgical treatment of the ores common to California (gold and quicksilver).	University of California. Industrial Accident Commission of California.
C. E. Van Barneveld	Southwest Station at Tucson, Ariz..	1916	Metallurgy of the ores common to the Southwest and especially hydro-metallurgical treatment of low-grade copper ores.	University of Arizona. Miami Copper Co.
F. K. Ovitz	Northwest Station at Seattle, Wash.	1916	Problems connected with the mining and utilization of the coals of Alaska and the Pacific Northwest; also problems connected with the treatment of the nonferrous ores of those districts.	University of Washington. Oregon Bureau of Mines & Geology. University of Idaho.
J. A. Davis	Alaska Station at Fairbanks.......	1916	The problems connected with the mining industry in Alaska.	
R. T. Stull	Ceramic Station at Columbus, Ohio.	1917	Clay industries and ceramics.	Ohio State University.
C. E. Julihn	Lake Superior Station at Minneapolis, Minn.	1917	The problems connected with the mining and beneficiation of low-grade iron ores, manganese ores, and other ores of the Lake Superior District.	University of Minnesota.
W. P. Dykema	Petroleum Station at Bartlesville, Okla.	1917	Problems connected with the production of petroleum and the conservation and utilization of petroleum and natural gas.	

maintained of much more interest to chemists and metallurgists, and it is important to note that coal mining rescue investigations were responsible for the Bureau's invaluable assistance in developing poison gases for use against the Germans and gas masks for protection against enemy efforts in the same direction. Therefore a description of the station and its activities will doubtless be of general interest.

LOCATION OF NEW BUILDING

The new building itself was planned in a general way by the first director, Dr. Holmes, who early visualized the wide field of the Bureau. It was largely through his efforts that the Forbes street site and the necessary appropriation were secured. Construction of the main building was completed late in 1917. Located on the edge of Schenley Park, flanked on either side by the Carnegie Institute of Technology and the magnificent museum, it is situated in the close vicinity of the center of intellectual and scientific life of Pittsburgh. Thus the resources of the University of Pittsburgh, the Mellon Institute and of kindred institutions are readily available. A front view is given in Fig. 1. Fig. 2 is a view of the buildings from the rear; the central portion is occupied by general and administrative offices, while at the rear is an adequately equipped auditorium capable of seating 240 persons (Fig. 3), available for public use at nominal charges. Laboratories occupy the east and west wings, while in the foreground of Fig. 2 is shown the power house, necessary to house the large-scale combustion or boiler tests on carload lots of various coals. From the front, the main entrance is a massive archway, a monolith in concrete; eagle, decorations and all details forming one great block, to which a special treatment has given a surface accurately imitating granite, altogether a fine and artistic piece of work. An idea of the general interior finish may be had from Fig. 4, which shows the entrance hall and a corridor leading to the west wing, finished in pressed brick and ornamental tile, while the analytical laboratories are furnished with an eye to utility, as shown in Fig. 5.

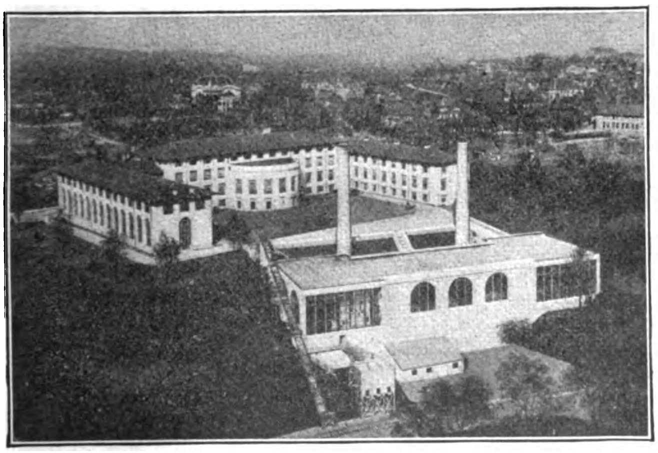
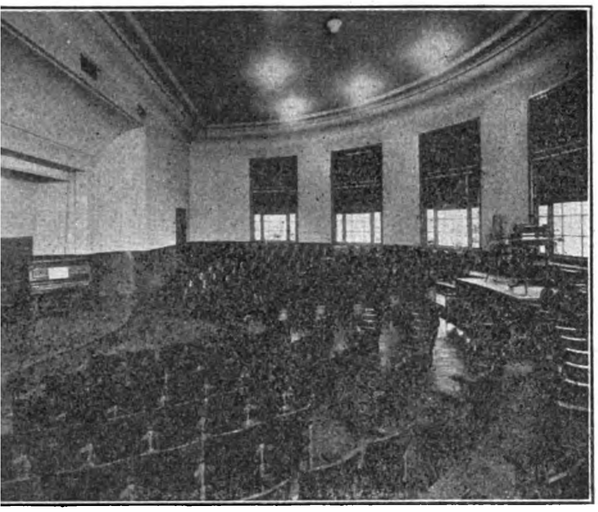


FIG. 2. PITTSBURGH STATION, BUREAU OF MINES; VIEW FROM THE REAR, SHOWING POWER HOUSE, EAST AND WEST WINGS AND AUDITORIUM

The central portion of the building is occupied on the ground floor by administrative offices and conference rooms, and the library occupies a portion of the second floor. A mess hall and quarters for the drafting, computing and photography divisions occupy the top. Pittsburgh houses the largest of the seven branch libraries of the main Bureau library in Washington, having some 6600 books and regularly receiving nearly 200 periodicals. Its scope covers physics, chemistry, geology, mechanical and electrical engineering, mining, metallurgy, chemical technology, industrial safety, hygiene, and miners' occupational diseases.

In order to eliminate routine work by investigators, the station has a corps of draftsmen, photographers, computers and clerks, who co-operate with the specialists in the design of special equipment, in the reduction of notes, and in the preparation of data and illustrations for reports. A well-equipped instrument shop is also provided which is manned by tool-makers and glass-



3. THE AUDITORIUM OF THE BUREAU OF MINES LABORATORIES

ers capable of building scientific equipment. In
:ion to routine work of this kind, the photographic
rtment is equipped and manned to take, develop
exhibit motion pictures, thus constituting an im-
int element in the Bureau's educational campaign
promoting safety and health among miners. About
reels are now available for public exhibition. The
au's equipment is complete for taking films on the
ice, within buildings or under ground. Usually, the
sures are made in co-operation with the mine or
: to be pictured, the Bureau furnishing the appa-
s, technician and film, while the co-operator fur-
es the incidental help and necessary arrange-
s.

spacious mechanical laboratory occupies the entire
of the west wing, being two stories in height.
ng the war it was occupied by a large assortment
ysical testing machines borrowed from educational
tutions for ordnance work. Apparatus actually
ging to the Bureau is yet somewhat meager; in
almost the entire west wing is provided in antic-
on of future activities of the organization, as yet
rmulated. Considerable space on the top floor is
ted to the investigation and certification of various
rical systems and items of equipment for safe use
assy and dusty mines.

RESEARCHES ON GAS

s investigations and mine rescue work is centered
e basement of the central portion and east wing,
important auxiliary chambers and equipment at
xperimental mine, a few miles distant at Bruceton.
efore noted, these were the first and yet remain the
amental investigations of this particular station.
le. not directly interesting to chemists or metal-
ists, it is worthy of note that such work, centering
Pittsburgh for about ten years, gave the Bureau
re of information on suffocating gases which was
kly turned to account in the late war. It is perhaps
known that the Bureau proposed a line of investi-
on which was eagerly indorsed by the War De-
ment months before we entered the war. Investi-
ns in gas offense and defense were well under
when war was formally declared, and were then
ied on for some five months by the Bureau's own
rces. Starting from a modest nucleus, by mid-
mer of 1917 about 50 experts were engaged in this work, mostly at American University, Washington, where were early transferred all these activities, and when finally the work was organized as the Chemical Research Division of Gas Defense and taken over completely by the War Department, about 1500 men were intensively studying problems in gas warfare.

Much of the data so secured should be available for industry, and the Pittsburgh station already has work well under way looking toward the application of the Army type of gas mask to industrial uses. Small concentrations of CO, NH_3, SO_2 and finest dust are extremely disagreeable and often quite dangerous if endured continuously, and proper canister fillings for their absorption have already been formulated. Much publicity has recently been given to this phase of the Bureau's work.

METALLURGICAL ACTIVITIES

Metallurgy also has quarters in the basement of the east wing. Eventually, it is planned to center here important investigative work on iron and steel worthy of the volume of the industry in this vicinity, but for several years the work has been limited not only by a lack of funds, but by lack of requisite personnel. For the last three years the press of demand for steel products was so insistent that men of proper caliber were almost entirely engrossed in getting out the production.

Very important laboratory work was done during the war, however, for the district Ordnance Office. In this the Bureau of Mines acted as host and did all the metallographical work, while physical and chemical testing was done at the station, by enlisted personnel of the War Department. Thousands of tests were made on various classes of metallic ordnance, and detailed investigations of the causes and remedies of certain defects brought to a successful conclusion. For the future of metallurgy at the Pittsburgh station, the present idea is not to establish extensive research laboratories so much as it is to co-operate with existing agencies and corporations in desirable lines of investigation. Thus, in steel, flaky structure and allied defects in alloy steels are still under consideration. An exhaustive investigation of the whole subject of heat-treatment of low-carbon steels is to be started in co-operation with the Bureau of Standards and interested manufacturers, the work probably to be done in Dr. Howe's laboratory

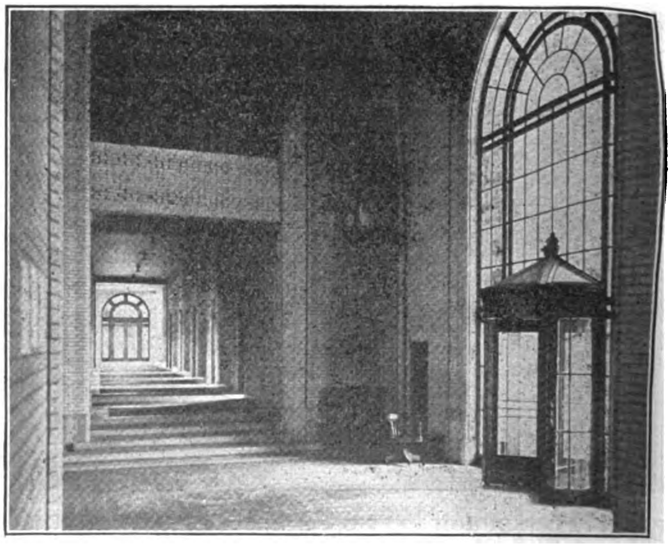


FIG. 4. ENTRANCE HALL

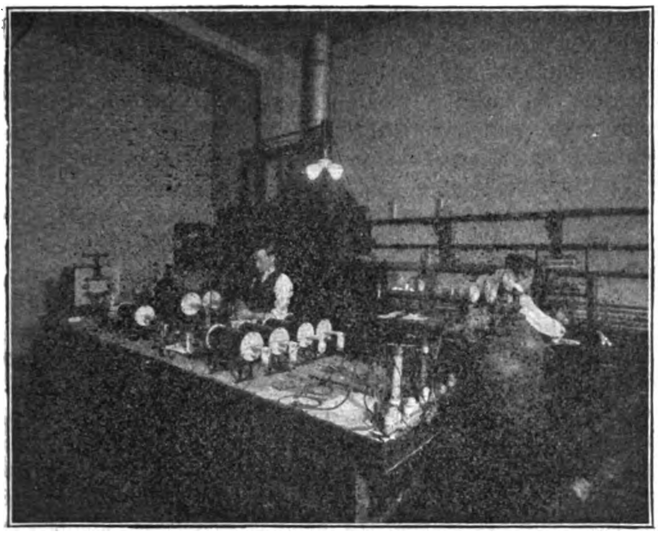


FIG. 5. TYPICAL ANALYTICAL LABORATORY

in Malvern Hills. In iron, a field investigation of factors of blast-furnace operation is under way, paralleling a like study of ferromanganese production which has been completed. Work on slags is also to be continued in co-operation with the committee on blast-furnace slags of the National Research Council.

In non-ferrous metallurgy, aside from the work on brass and bronze, which has been under way for a long time at Ithica (Cornell University), an investigation of foundry practice in aluminum has been started at Pittsburgh. It is hoped to formulate perfected melting and casting methods so that waste and scrappage may be largely reduced, primarily by the reduction of porosity, oxide and gas inclusions. In this connection the relative merits of proposed aluminum alloys will be considered as well as the relation between the quality of ingot metal to the resulting casting.

Chemical Laboratories

Chemical analysis occupies the bulk of the first floor of the east wing. The analysis of fuels for use of various departments of the United States Government is one of the chief duties of the analytical laboratory. Many samples of coal, coke, ores and other materials collected incidental to various investigations by the Bureau or co-operating institutions are also analyzed.

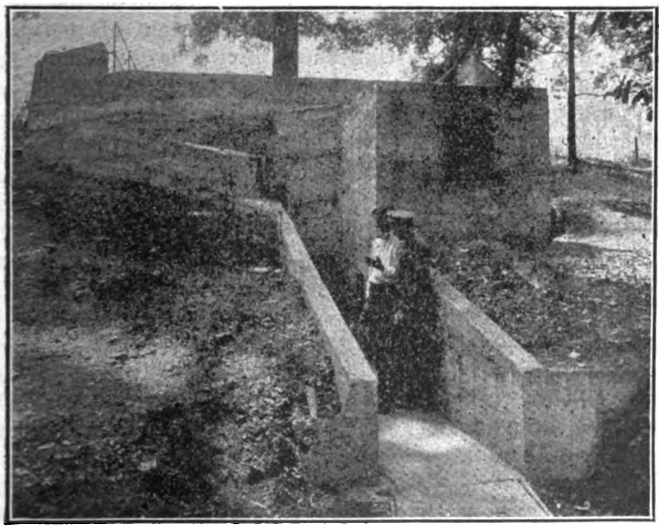


FIG. 6. BOMB PROOF FOR TESTING EXPLOSIVES

Here, also, has been under way the extensive researches on the fusibility of coal ash, which will be of much use in determining the liability of any fuel to cause excessive trouble from clinkering.

Explosive Testing

Perhaps the most interesting work being done at Pittsburgh, however, from a chemist's standpoint, is the investigations on explosives under way in the laboratories on the second floor, west wing, and at the testing plant at Bruceton, where all physical tests are conducted. At the latter point is installed equipment for investigating the gases evolved by explosions (most important in metal mining), the "permissability" of explosives in coal mining, and the rate of detonation (which largely measures the shattering effect), such apparatus consisting of two long galleries, three bombproofs, such as shown in Fig. 6, several separate magazines and instrument shelters, a ballistic pendulum, Mettegang recorder (Fig. 7), two impact machines, a pendulum friction machine, flame-testing apparatus, Bichel gages, a calorimeter and a variety of lead block expansion and compression test equipment. All the physical characteristics of explosives and different kinds of blasting supplies are here investigated in order that they may be classified so a user may have information on any of the various dangers attending their use, particularly in mines.

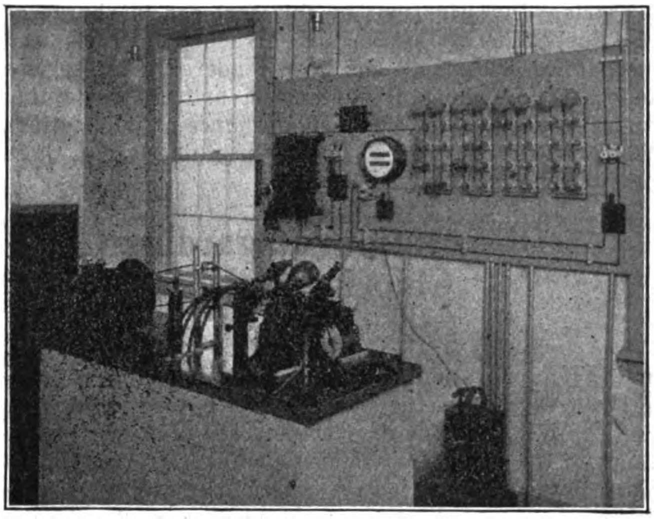


FIG. 7. METTEGANG RECORDER

Routine analyses of explosives are made at the chemical laboratory, periodically checking the composition of the "permissible" explosives on the market. Much work is also done on purchases of explosives by various Government departments; during the war, especially, the Bureau co-operated with the War Department on grenade fillers, shell fillers, gun greases, and on the proposed substitution of flax and the down of milk-weed, cat-tail and white smoke-root for cotton and for glycerine in the manufacture of nitroglycerine. In the analytical work a continual effort is made to perfect the methods as to speed and accuracy, and much valuable work along these lines has been published. For instance, work is now under way on a modification of the sand test for detonators to give results more nearly proportional to the quantities of priming employed. As is perhaps well known, this test is made by placing an electrically fired detonator in the center of a definite quantity of standard sand contained in a steel block.

After explosion the sand is sifted and the amount of crushing is a measure of strength of the priming; it is also possible to determine whether detonation has been complete.

New explosives are also investigated. Thus, a series of tests on propylene glycol denitrate as a substitute for nitroglycerine has been completed, as well as much work on a cartridge composed of carbonaceous matter and liquid oxygen.

Power Plant

As may be seen from the view, Fig. 2, advantage has been taken of topography to place the powerhouse on a low level, behind the main building and out of sight from the front. It is a reinforced-concrete structure 55 by 220 ft., divided into three parts. At the west end is the fuel-handling equipment and three water-tube boilers. In the center of the building are installed the engines and electric generators, while the space at the east end is destined for apparatus for the study of heat transmission through boiler tubes, the study of combustion process within the fuel bed, and of problems of efficiency in domestic heating equipment of all sorts. Investigations of this sort are in charge of the fuel-efficiency section of division of fuels and mechanical equipment, and have rendered great service to other governmental bureaus in matters pertaining to fuel economy, and led to the issuance of publications that are believed to be of greater usefulness than those previously available.

Observations Regarding Chlorine Cells

By F. G. Wheeler

IN THE operation of all chemical machinery, questions regarding the various forms of construction and the best methods of operation are of prime importance to the engineer. This is particularly true of the electrolytic alkali industry, where many varying conditions in the application of the process exist. To answer some of these questions, the writer has experimented for many years, and has investigated many phases of this process. The results of these experiments have been embodied in several plants which are working on a large commercial scale today.

The most prominent questions which were solved were those regarding the efficiency of a cell, the overload capacity, the influence of temperature, the problem of feeding a cell constantly with brine, the impregnation of anodes, and the many conditions governing cell operation.

The type of cell which the writer adopted is one the form of which was first used by James Hargreaves in 1894. It was later developed by James Mercer and put into practical operation at Haverhill, Mass., in 1898. It was also used by Merry and Noble in England and later by Arthur Gibbs in the United States. The cell is cylindrical in form and built so that the entire exterior surface is cathode. Like a drum, it is able to withstand pressure from within without bracing and without distortion. This form of cell has been adopted by several of the largest electrolytic alkali manufacturers, and there are undoubtedly more cells of this type in operation than any other one form, and possibly all forms combined.

The cylindrical shape has the advantage of requiring no joints except those at the ends, which are held tight by means of a hoop. As a barrel is one of the cheapest forms of package, this form of cell is the cheapest to build. It adapts itself with the greatest ease to the many varying conditions which arise and is remarkably successful from a commercial standpoint.

The efficiency of a cell, by which we mean the proportion of product made compared to the amount of electricity used, was early observed by Hargreaves to be a function of the strength of liquor delivered, that is, the lower the percentage of hydroxide in the cathode liquor, the higher the efficiency. Hargreaves concluded that it was impossible to produce caustic soda with an electrolytic cell because of this action of the concentrated caustic soda. He fully understood the fact that if brine were passed through a diaphragm in contact with a perforated sheet of metal, which was made the cathode of a cell, and if one-half of the brine or less were converted to caustic soda, an efficiency approximating unity was easily obtained. He also used the idea of adding steam to the empty cathode compartment in order to wash the caustic away from the cathode to prevent the hydroxide ions from migrating into the anode solution. His idea, however, was to make a pure product in the cell, and he did not consider the manufacture of a solution of caustic soda mixed with salt and purifying it for commercial use.

The Diaphragm Problem

In our first experiments, we found that the caustic could be washed away from the cathode by using a very thin diaphragm which was very easily permeable to the brine. In the commercial operation of a cell, the diaphragm becomes plugged, not only with the impurities which might escape the filters, but with those made in the cell itself, such as disintegrated graphite, and from the action of the liquor on the diaphragm itself. It is obvious from this that the thinner a diaphragm can be made, the more slowly will it become impermeable. It is also apparent that the thinner it is, the less capillary action is present to hold the caustic soda solution between the two electrodes after it has once been formed.

The problem of making cheaply a very thin diaphragm is one of using a cathode which will hold such a diaphragm in position. The idea of supporting a diaphragm with the cathode is an old one and was used first by Hargreaves, and mentioned in his patent of Dec. 28, 1897. To apply this principle, a cathode was first designed using two sheets of metal. The inner sheet was a thin sheet having large perforations, and the outer was a heavier one having fine perforations. The idea was to place a thin sheet of asbestos paper against the inner sheet of the cathode. When it would attempt to burst through the large perforation of the inner sheet due to the pressure of the brine from within, the outer sheet would prevent its rupture, yet would still allow the products of electrolysis to be removed from the field of reaction.

A double cathode of this type is expensive to build and difficult to handle, so that a single sheet was devised which had all of the advantages of the double sheet. This cathode is made by displacing the metal removed from the large perforation backward, but not detaching it from one edge, leaving the flap in such a position that it prevents rupture of the diaphragm, but still leaves a three-sided perforation for the removal of the products of electrolysis.

A cell with this cathode is so designed that the edge formed in each large perforation is not thick enough to cut the diaphragm, yet at the same time the sheet of metal is heavy enough to conduct the current economically. These properties have been ascertained, so the constructon of a commercial cell is simple.

Cells built as described have an efficiency approximating unity over long periods of time, and plants are now operating with a commercial efficiency of over 95 per cent with no difficulties from diaphragms or cathodes.

Many industries require cells which can be shut down without damage, so this question was carefully examined. The usual difficulties connected with shutting down a cell arise from changes of temperature and also changes in the delivery of the hydrogen gas. The caustic soda which is formed on the cathode passes with the hydrogen gas through the openings in the cathode and is discharged into the cathode chamber. When a cell is shut down, the evolution of the hydrogen ceases, together with the consequent reducing action of the nascent hydrogen at the cathode. The diaphragm is then pressed against the cathode by the brine in such a way that the tiny passages which have been occupied by hydrogen are closed. The chlorine in the brine is not reduced by the nascent hydrogen evolved at the cathode during operation, but attacks the metal, forming ferric chloride. This passes with the brine into the cathode compartment of the cell. A small amount is retained in the diaphragm by capillary action. When the current is again started, the caustic soda, which is first formed, changes the ferric chloride into gelatinous ferric hydroxide, which partially plugs the diaphragm. The hydrogen formed simultaneously with the caustic soda has no easy method of egress or open passages, but must force its way through the pulpy diaphragm until it reaches the nearest opening in the cathode. The cells, therefore, do not deliver the caustic after a shut-down as easily as they did before. As the cell becomes warmer, the viscosity of the brine decreases so that it flows through the diaphragm more readily, the ferric hydroxide is slowly removed by the brine, the hydrogen creates passages to the nearest openings, and the cell returns to its previous operating condition.

EFFECT OF STEAM TREATMENT

The effect of steam, which is blown into the cathode compartment, was tested with various results. As predicted by Hargreaves, the steam dilutes the caustic soda on the cathode, and in this way helps to keep the efficiency of a cell high. The condensation of the steam on the jacket is easily cared for by trapping it away from the cathode liquor, so that this steam does not dilute the solution, but the condensation on the cathode itself has to be re-evaporated in the concentration department. The steam keeps the cell hot, lowers the viscosity of the brine, causing it to flow more easily through the diaphragm, reduces the concentration of the hydroxide ions, increasing the efficiency. A cell was operated for several months at an efficiency so close to unity that the difference could not be found by ordinary experiments. Cells which were old and worn out, and had been impermeable to the brine, were treated with steam and responded as mentioned above, the efficiency being increased somewhat, but the cost of renewal of a diaphragm is so small, about $3, and the additional cost of reconcentrating the solution so high, that no real advantage is gained. The question is simply a commercial one. If power is expensive, it may pay to use steam to save power, but where the power is cheap, the question would be an entirely different one.

RATING OF CELLS

Many cells are given a normal rating, which is described as being so many amperes. The writer often wondered upon what facts this capacity rating was based. Accordingly, an experiment was tried in which a cell was subjected to an enormous current with the hope of learning what would happen when an excess of current was passed through the cell. A cell was selected which would carry 750 amp. at 3.5 v. By means of an experimental generator, an additional current was superimposed upon the regular current, with the result that this cell carried 2300 amp. at 4 v. Unfortunately, the experimental generator could not be operated at a higher current, but the experiment was continued, with the result that at the end of four weeks two cells, which had been carrying 2300 amp. for this length of time, were delivering 93 per cent of the theoretical amount of caustic soda. We naturally concluded that there was no specific rating for any cell. If power is cheap, it is obvious that it does not pay to install a large number of cells and work them at a low current. The interest and depreciation on the cells will more than offset the power which is saved by operating these cells at a low voltage, and it therefore pays to use a higher voltage and pass a higher current. The whole question was worked out very carefully, numerous curves were drawn, and it was found that a minimum cost could be easily ascertained when local conditions were considered.

FEEDING DEVICE FOR SUPPLYING BRINE

Another phase of the subject is the method of supplying the brine to a cell. A successful feeding device must be one which has in it several important features. In the first place, it must be foolproof and require practically no attention when once started. It must maintain the level in the cell automatically, so as to keep conditions constant. It must be totally enclosed, so that no evaporation of brine will cause salt to crystallize in the feeding device. It must also have no constriction, nor can it be made to operate by means of a small aperture, for in any such device a particle of dirt, salt, or even an air bubble will cause it to fluctuate in the quantity of brine delivered. It must be cheap to construct. It must not allow any electrical current to flow through the brine being fed to the cell, because this to some extent grounds each cell and causes "electrolysis" in the pipe lines and other metallic parts of a plant. Bearing all of these things in mind, a feed was devised which delivers a broken stream through an enclosed piece of apparatus, in which there is no throttling effect and the quantity of brine delivered is controlled by the level in the cell itself. It consists in passing the brine through a chamber of gas. The gas in the chamber is held under a certain pressure due to the level of the brine in the cell, and this pressure regulates the brine being admitted to the chamber.

PROBLEM OF ELECTRODES

A very interesting experiment was made in connection with the preservation of graphite anodes. The first idea was to fill the pores of an anode with an inert material, which would prevent the current from detaching particles of graphite. In this way the anode would have a much longer "life" than without this treatment. The graphites were first impregnated with various oils. It was soon found that the excess of oil in the pores of the graphite was discharged and floated on the surface of the brine, then chlorinated, forming a wax. This prevented the chlorine from escaping from the cell, and caused trouble.

A method was devised in which the inside of each pore in the graphite was painted with an inert liquid, in such a way that the wall of the pore only would be covered. There was no excess of oil to be discharged from the graphite after it had once been treated. After this problem was solved, almost every kind of oil was tested. Not only the common oils, but such material as vulcanized oils and mixtures with asphalt and pitch were used. A good selection was finally made and thoroughly tried out. The question of impregnation resolved itself into one involving the cost of power. It seems that impregnation not only saves graphite by making the inner surface of the pores resistant to the chlorine, but it also presents a smaller surface for the electricity, in passing from the anode. The increase in the current density on the graphite is shown by an increased terminal voltage on the cells, with the result that an anode which has been impregnated requires more power per ton of product than a cell in which the anodes have not been impregnated. The problem becomes one of choosing whether the cost of impregnation plus the cost of power is cheaper than the cost of graphite. Where power is cheap, it pays to impregnate.

CONCLUSION

When a cell is constructed according to the principles which we have described, with a good feeding device, with the graphite either impregnated or not according to local conditions, made so that it will work at a high temperature, and with the proper local conditions taken into consideration, there is little difficulty in making a plant deliver caustic soda and chlorine at almost any efficiency desired, and at a voltage which will net a handsome profit even under some of the most difficult conditions.

Bureau of Foreign and Domestic Commerce Publishes the First of Its Educational Series

"Selling in Foreign Markets," by Dr. Guy Edward Snider, of the College of the City of New York, has just been published by the Bureau of Foreign and Domestic Commerce. This is a collection of readings of some 600 pages, covering in a logical and co-ordinated manner various phases of marketing American products abroad. The new movement in education for foreign trade, the keynote of which is the unit short course dealing with some specific phase of the subject in a detailed and concrete manner, disclosed the fact that literature of a specific nature is lacking. There has been a great deal published for general reading in foreign trade, but little has been written specifically for college work. The Bureau of Foreign and Domestic Commerce, in co-operation with the Federal Board for Vocational Education, is extremely desirous of having introduced into educational institutions, including reading circles, a type of foreign trade study as is supplied in its publication "Selling in Foreign Markets."

Synopsis of Recent Chemical and Metallurgical Literature

Stainless Steel.—The literature relating to this interesting alloy is exceedingly meager. Two contributions have been made recently, however, which throw some light upon the history and properties of this alloy, although the chemical composition is not disclosed.[1] Stainless steel was discovered in the research laboratories of Thos. Firth & Sons, Ltd., Sheffield, by Harry Brearley, while working on armor piercing projectiles for the Russian Government. It was soon found that the new alloy did not scale easily and did not tarnish when exposed to the action of many acids, including fruit acids. This suggested its use in the cutlery trade. R. F. Mosley's cutlery works was the first to use it for this purpose. The alloy is not protected by patents in England, but the foreign patents are controlled by the Firth-Brearley Stainless Steel Syndicate, with the exception of the American patents, which were sold to a co-operating body of large steel makers, the American Stainless Steel Co., of Pittsburgh. (U. S. P. 1,299,404, granted to Elwood Haynes on Apr. 1, 1919, and assigned to this company, relates to a chromium-iron alloy containing 20 to 25 per cent Cr and 0.1 to 0.5 per cent C, which is claimed to be practically permanent against fruit acids, exposure to air and rain, etc.).

This steel is capable of attaining, by suitable heat treatment, a wide variation in mechanical properties up to extreme hardness. It does not scale appreciably under 800 deg. C., while its tensile strength is not materially reduced at 400 deg. C. This property, in combination with the resistance to erosion, led to the use of the alloy for the manufacture of exhaust valves for airplane engines. Among other engineering applications of the alloy may be mentioned: Turbine blades, pump rods and valves, acid pumps, rams, cotters, evaporating pans, races and rollers for bearings, steam traps, etc. Since the steel is unaffected by salt water or sea air, it may be employed for a variety of marine purposes. In the electrical field, stainless steel is used for permanent magnets and for electric cooking stoves and utensils, where the advantages of permanently bright and clean surfaces in assisting the reflection of heat and consequent economy of current are immediately apparent.

A New Process for the Synthesis of Ammonia.—The Hampel-Steinau process for the synthetic manufacture of ammonia is described in the Dec. 18, 1918, issue of the *Technische Rundschau*. The examination of the patent previous to issue, by the German patent office, shows the principle to be completely new. In place of using a catalyzer to increase the velocity of combination of nitrogen and hydrogen, Hampel-Steinau utilize the properties of nascent hydrogen, combining it with nitrogen as it is in the act of being formed. The nascent hydrogen is produced by the action of chemical compounds on suitable metals, a large choice of detail being possible in this respect.

In the preferred form of the process, ammonium chloride acts on iron to produce the nascent hydrogen. It is well known that at 250 to 300 deg. C. ammonium chloride splits up into NH_3 and HCl. If iron is present, the HCl acts on the iron to produce hydrogen, thus furnishing the nascent hydrogen for the process. If nitrogen (made from liquid air) is also present, it unites with the hydrogen to produce NH_3. The iron chloride formed is brought into solution, and precipitated by part of the NH_3, enough being used to re-form the original quantity of NH_4Cl.

---

[1] "Story of Stainless Steel," *Iron Age*, July 31, 1919, p. 294 (taken from the *Organizer*, a British monthly); "Firth's Stainless Steel," *Electrician*, July 25, 1919, p. 97.

The reactions described may be thus set down:

$$6NH_4Cl = 6NH_3 + 6HCl$$
$$6HCl + 3Fe = 3FeCl_2 + 6H$$
$$6H + N_2 = 2NH_3$$
$$3FeCl_2 + 6NH_3 + 6H_2O = 3Fe(OH)_2 + 6NH_4Cl$$

The first three reactions, being in reality simultaneous, may be written thus:

$$6NH_4Cl + 3Fe + N_2 = 3FeCl_2 + 8NH_3$$

Six of the eight molecules of NH_3 are used to regenerate the NH_4Cl, leaving a gain of $2NH_3$, while the iron hydrate precipitate is filtered out, dried, and treated by reducing gases to regenerate the iron powder. The whole process is thus a circle, with only water and nitrogen coming in and NH_3 coming out.

The process goes on smoothly in the particular apparatus which has been devised for it. With 50 atmospheres pressure and at about 300 deg. C., the gas mixture obtained is 98 to 99 per cent NH_3, of which three-quarters goes back into the process for precipitation of the iron salt, leaving 23 to 24 per cent of the ammonia as clear gain. The apparatus is only slightly attacked, and no ammonium chloride is lost.

The nitrogen needs to be prepared, as in other processes, but not the hydrogen. The gas obtained is 98 to 99 per cent ammonia. The advantages of the process appear to be numerous.

Recent Chemical and Metallurgical Patents

Complete specifications of any of the United States patents may be obtained by remitting 5c. each to the Commissioner of Patents, Washington, D. C.

Rare Earth Oxide Ceramic Structure.—The increase of electrical conductivity with increase in temperature shown by ceramic materials containing silicates, such as porcelain, earthenware, etc., is explained by the theory that devitrification of fused silica is due to depolymerization of large silica molecules, giving a greater number of charge-carrying bodies. On the basis of this assumption, CHARLES KNOX HARDING of Chicago has studied the possibility of producing insulating ceramic materials free from silica. He has found that the neutral tri-valent and tetra-valent earth oxides, such as lanthanum, thorium, zirconium and didymium, are especially suitable for this purpose. They may be obtained from monazite sand. As an example, finely ground calcined lanthanum oxide with air dry lanthanum phosphate and 6 to 12 per cent gelatinous lanthanum hydroxide may be subjected to a high pressure in a metal die and formed into a very compact structure which will not check in air drying and which may be fired to a very high temperature (above Seger cone 20) without injury. (1,296,076; Mar. 4, 1919.)

Metallic Magnesium From Magnesium Oxide.—Attempts to produce magnesium by a method similar to that used for aluminum have been unsuccessful, owing to the slight solubility of the oxide in the double fluorides of magnesium. GEORGE O. SEWARD has found that triple fluorides of magnesium, barium and sodium, such as $MgF_2 : BaF_2 : NaF$ (sp. gr. 3.22), have specific gravities so nearly approaching that of magnesium oxide (3.60) that the bulk of the latter will remain in suspension in the molten bath. Some of the oxides floats on the surface, thus preventing the escape of free fluorine and at the same time protecting the anodes from "necking in" by oxidation just above the electrolyte. Although the oxide dissolves to the extent of only 0.1 per cent in the bath, the oxide in solution is replenished as electrolysis proceeds by the large excess of oxide in suspension. It is also possible to use magnesium carbonate, as this calcines quietly to the oxide, while floating on the bath. The cell is similar to the modern aluminum furnace. Molten copper is used as cathode, since it forms fusible alloys with magnesium but does not readily alloy with sodium. The working temperature is about 950 deg. C. and the current density 400 amp. per sq.ft. of cathode surface. (1,310,449 and 1,310,450; assigned to American Magnesium Corp.; July 22, 1919.)

Electric Furnace Electrode.—MARK SHOELD of Chicago, Ill., has devised an electric arc furnace electrode which is capable of being built in larger sizes than is at present practical, by combining seven small cylindrical electrodes into one unit. This arrangement has several advantages: an accident to one element will not seriously interfere with the furnace operation; the current density is reduced because of the larger surface area; the individual elements are less prone to damage caused by the warping and twisting stresses. (1,313,126, Aug. 12, 1919; assigned to Armour Fertilizer Works, Chicago.)

Clay Binder and Process for Making Same.—HENRY L. KOHLER of St. Louis, Mo., improves the quality of fire-clay brick and makes possible the manufacture of brick from clays which do not in themselves contain sufficient bonding properties. This is accomplished by adding from ½ to 5 per cent of anhydrous aluminum sulphate to the finely pulverized clay, which has been previously mixed with a certain amount of water. The aluminum sulphate crystallizes by combination with this water and thus acts as a temporary binder, making it possible to mold the product. In the molded product, after standing for a sufficient length of time, the aluminum sulphate reacts with aluminum silicate, forming basic aluminum sulphate and silicic acid. Upon burning, the sulphates are converted into oxides and the silicic acid into aluminum silicates, these acting as binders. The products are more resistant to disintegration caused by temperature changes and a larger percentage of perfect brick results from this method of manufacture. (1,312,853, Aug. 12, 1919.)

Electric Furnace.—JAMES H. GRAY of New York City designs the tilting device of an electric furnace so that the center of rotation is near the top of the furnace roof. This arrangement permits of supporting the electrodes and cooling rings from above by means of cables. The electrodes are thus held stationary while the charge is being poured, and are thereby relieved of the strains produced when the electrodes are tilted with the furnace. The mechanical details of furnace construction are simplified, because it is not necessary to design the furnace to support the weight of the electrodes, cooling rings and their appurtenances. The design is of particular advantage when large currents are supplied at low voltage; the large sized flexible conductors required to carry the current are much shorter than in the usual design. (1,313,890, Aug. 26, 1919.)

Oxalic Acid From Paper Mill Waste Liquors.—Waste liquor is evaporated so that a dry or semi-dry residue is obtained. This is mixed with four times its weight of caustic alkali and heated in thin layers for 6 hr. at 250 deg. C. Sufficient water is added to dissolve the excess alkali and soluble organic material, leaving sodium oxalate in the residue. A second leaching with fresh water dissolves the sodium oxalate. From this solution, oxalic acid is recovered in the ordinary manner by precipitating calcium oxalate and decomposing this with sulphuric acid. (1,310,713; HERBERT C. REED of Stamford, Conn.; July 22, 1919.)

Use of Trinitro-Nitranilid and Sulphocyanates in Primers.—In place of mercury fulminate, WILLIAM H. BUELL proposes to use 2.4.6-trinitro-nitranilid, $C_6H_2(NO_2)_3NHNO_2$, with potassium chlorate, antimony sulphide and sulphocyanates of lead, copper, etc., in the proportion of 10, 50, 15 and 25 parts by weight, respectively. (1,311,872; assigned to E. I. du Pont de Nemours & Co.; Aug. 5, 1919.)

Annual Sample Fair at Barcelona

There has recently been organized in Barcelona a corporation under the title of "Feria de Barcelona, S. A.," with a capital of 500,000 pesetas ($100,000), for the purpose of holding annual sample fairs similar to those of Lyons, Bordeaux and Leipzig. The mayor of Barcelona will be president of the executive committee. Preparations are under way for holding the first fair during the spring of 1920.

Book Reviews

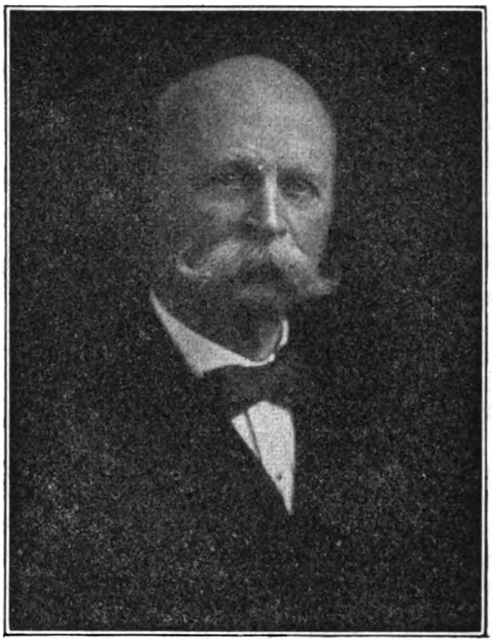
THE JOURNAL OF THE INSTITUTE OF METALS, Vol. XXI. Edited by *G. Shaw Scott, M. Sc.*, Secretary. 508 pages. London: The Institute, 36 Victoria Street, Westminster, S. W. 1.

This volume, one of the most important if not the largest yet published by the Institute of Metals, contains the lengthy "Fourth Report of the Corrosion Committee," by Guy D. Bengough and O. F. Hudson. After a brief consideration of current theories of corrosion, the authors present the result of their own detailed experimentation on the corrosion of zinc, copper, aluminum and brass, this part alone occupying over 100 pages of text. Next follows Part II, on the corrosion of condenser tubes, which was briefly abstracted in CHEMICAL & METALLURGICAL ENGINEERING for June 1, 1919, p. 594. Finally, the authors conclude with 15 pages of notes on the practical aspects of the corrosion problem, such as the effect of scale, methods of electrolytic protection, and other methods of hindering corrosion. Altogether, with discussion, this report occupies some 250 pages.

It is safe to say that this report is by far the most important publication on corrosion which has appeared in the last five years, and consequently the volume will be found indispensable to all students of this most important waste in metallic materials. In addition to the corrosion report, this volume of the Journal contains its usual array of authoritative papers on non-ferrous metallurgy, such as micrography of aluminum and its alloys, and the effect of work on various alloys. Fifty pages of abstracts of the literature complete the volume—a feature in itself which is of great importance. E. E. THUM.

Obituary

Dr. E. G. LOVE, treasurer of the American Chemical Society, former president of the Chemists' Club, and for a long time chairman of its house committee, died Friday evening, Sept. 12, from surgical shock following an operation. He was 69 years of age. He was a graduate of Hamilton College and of Columbia University, and in 1877 was made gas examiner for the City of New York. For many years he maintained a laboratory in New York City, and several years ago was made chief chemist for the Consolidated Gas Co. Dr. LOVE was very well known among the chemists of America, and had been active at meetings of chemical bodies for many years. He was a man of rare popularity.



Copyright, Underwood & Underwood

DR. E. G. LOVE

Personal

Dr. L. H. BAEKELAND, honorary professor of chemical engineering in Columbia University, has been decorated by King Albert with the Order of the Crown of Belgium.

Major F. E. BREITHUT, Chemical Warfare Service, has been honorably discharged from the Army. Dr. Breithut has resigned as assistant professor of chemistry at the College of the City of New York to take a position with the Foundation Oven Corporation, Woolworth Bldg., New York City.

Mr. H. K. DAVIES, formerly with Wallace & Tiernan Co., Inc., of New York City, has recently entered the employ of the Pennsylvania Salt Manufacturing Co., Widner Bldg., Philadelphia, Pa., for the purpose of developing the use of liquid chlorine.

Mr. CHARLES U. GEESEY, engineer of tests and metallurgist, U. S. Ordnance, during the war and formerly with the Gary Works of the U. S. Steel Corporation, has joined the executive force of the Garford Motor Truck Co., Lima, Ohio, as chief chemist, metallurgist and adviser to the heat-treatment department.

Mr. H. E. HARING, for the last two years in the inspection division of the Ordnance Department, is now connected with the Bureau of Standards, where he will be engaged in electrochemical research.

Dr. **Charles L. Parsons**, chief chemist, has tendered his resignation from the Bureau of Mines, to become effective Nov. 1. On that date he will open an office in the Mills Building annex at Washington, D. C., where he will conduct the Washington office of the American Chemical Society and in addition will do private work.

Prof. J. W. **Richards**, Lehigh University, South Bethlehem, has returned to the United States after spending the summer in Denmark, Norway and Sweden.

Dr. **Theodore W. Richards**, professor of chemistry at Harvard University, has been elected president of the American Academy of Arts and Sciences.

Mr. **Edgar S. Ross**, formerly chief chemist for the Charlotte Chemical Laboratories and Columbite Reduction Co. of Charlotte, N. C., is now located at New Hampshire College, Durham, N. H., where he will carry out special research in the rare earths in conjunction with Professor C. James.

Major General **William L. Sibert**, director of the Chemical Warfare Service, U. S. A., has been made a commander of the French Legion of Honor.

Prof. **Alexander Smith**, head of the department of chemistry at Columbia University, was granted on July 10 the honorary degree of doctor of laws by the University of Edinburgh.

Lt.-Col. C. G. **Storm**, Ordnance Department, U. S. A., chief of the Research Section, Ammunition Division, has been honorably discharged from the service and is now engaged in research work with the Pennsylvania Trojan Powder Co., Allentown, Pa.

Dr. J. P. **Street**, chemist in charge of the analytical laboratory of the Connecticut Agricultural Experiment Station, and recently major in the Sanitary Corps of the U. S. Army, has been assigned by the National Canners' Association as chief inspector for the State of Indiana.

Current Market Reports

The Non-Ferrous Metal Market

Tuesday, Sept. 23.—Pending the restoration of normal conditions in the steel industry, little business is being transacted in the non-ferrous metal market.

Aluminum:—The market remains quiet, with 98-99 per cent ingots at 33c. per lb. There is a fair demand for scraps; cast, 21¼-24½c.; sheet, 21-23½c.; clippings, 23¼-27½c.

Antimony:—The market is quiet; spot wholesale lots being offered at 8¾c. and job lots at 8¾-8⅞c.

Copper:—Reports indicate favorable prospects for a buying movement when the steel situation is relieved. Spot and September are quoted at 23½c. lb., October and November, 24c.

Copper sheets, hot-rolled	lb.	33.50 —	......
Copper sheets, cold rolled	lb.	35.00 —	......
Copper bottoms	lb.	41.50 —	......
Copper rods	lb.	24.75 —	......
Copper wire	lb.	26.00 —	......
High brass wire and sheets	lb.	27.75 —	......
High brass rods	lb.	26.75 —	......
Low brass wires and sheets	lb.	30.50 —	......
Low brass rods	lb.	31.25 —	......
Brazed brass tubing	lb.	39.00 —	......
Brazed bronze tubing	lb.	44.25 —	......
Seamless copper tubing	lb.	37.50 —	......
Seamless bronze tubing	lb.	44.25 —	......
Seamless brass tubing	lb.	36.00 —	......
Scrap, heavy machinery comp		17½ —	18½
Scrap, heavy and wire		17½ —	18½
Scrap, light and bottoms		15½ —	16½
Scrap, heavy, cut and crucible		19 —	20
Scrap brass, heavy		10½ —	11½
Scrap brass, casting		12 —	12½
Scrap brass, light		9½ —	10½
Scrap, No. 1 clean brass turnings		10¼ —	10¾
Scrap, No. 1 comp. turnings		16½ —	16½

Lead:—The market is firm, spot New York being 6.07½-6.25c. and East St. Louis, 5.85-6c. lb.

Tin: London reports indicate a further decline. Straits spots are quoted on the New York market at 55c., with 99 per cent electrolytic at 54½c. lb.

Zinc:—The falling off of the demand from the steel companies caused a further drop in price. Spot New York, 7.30c. lb.; October, 7.35c.; November, 7.37½c.; December, 7.40c. East St. Louis spot, 7.00-7.05c.; October, 7.10c.; November, 7.15c.; December, 7.17½c.

OTHER METALS

Bismuth	lb.	$2.95 —	.....
Cadmium	lb.	1.50 —	$1.75
Cobalt	lb.	2.50 —	3.50
Magnesium	lb.	1.75 —	2.10
Mercury	75 lb.	105.00 —	108.00
Nickel	lb.	.41 —	.45
Iridium	oz.	175.00 —	.....
Palladium	oz.	115.00 —	120.00
Platinum	oz.	110.00 —	115.00
Silver	oz.	1.15⅛—	.....

The Iron and Steel Market

The iron and steel markets were more or less influenced during August and the fore part of September by threats of a strike in the industry. Since the strike began Monday, Sept. 22, there has been no distinct market situation, the strike being the sole item of interest.

The strike may be described from several different angles as follows:

(1) It is a strike of common labor almost wholly. Of the common labor the strikers are mainly the foreign born, as it was only to them in their ignorance that a strong appeal could be made by the agitators.

(2) It varies in intensity in districts, in the order of intensity approximately as follows: Wheeling, Youngstown, Calumet (Chicago and Gary), Lake Erie front, the Pittsburgh district, the South, the East. There is practically no strike east of Johnstown, Pa., and Buffalo, N. Y., while the Cambria and Lackawanna plants, respectively, at those points are closed completely.

(3) It affected the Steel Corporation and independents about equally, but as the East did not strike and is wholly independent, the remainder of the industry showed more strike for the independents than for the Steel Corporation.

(4) The strike being of common labor, it affected plants making various products in about the same proportion.

After a careful scrutiny of reports covering practically all points it may be estimated that the strike closed about 35 per cent of the productive capacity. The curtailment in output was greater than this, because in the matter of a strike it is not tonnage output that counts, but employment. As long as a plant is operating it counts against the strikers, because men are working in it, whether or not the output is in proportion to the number of men working.

On the whole, the strike was not altogether as extensive as the manufacturers expected, in case the strike call were persisted in at all. The strike order was issued Sept. 10, for Sept. 22, but in the interim there was almost continuous doubt as to whether or not the order would be recalled. It is not certain, however, that the strike disappointed the agitators, who, by their conduct beforehand, had given many inklings that they were doubtful of being able to produce a strike of any magnitude. That they would call a strike when such doubt existed is not strange, for they knew one thing quite well, that their chances of success were at the peak. They had produced a certain amount of excitement and unrest among the men and had no means of maintaining the excitement. This could be done only by an active force. The excitement did not tend to maintain itself, but would die out if not nurtured. It was a species of mob psychology, in which these labor agitators are fairly well versed or they would be unable to agitate.

Being of common labor, the strike affected blast-furnaces more than steel works, where the works were operated in conjunction, but by reason of so many merchant blast-furnaces being scattered, and largely free from strike on that account, there is more or less of an even break between the proportion of steel capacity and of blast-furnace capacity affected. In the Mahoning and Shenango valleys, where merchant furnaces are close together, there were few that did not have to bank.

The districts did much as was to be expected. The Wheeling district has always been strong for strikes, and some of the plants were closed by the managements in advance, it being fully realized that a strike would occur. Almost the entire district was idle the first day of the strike. Youngstown was closed practically tight within a day or so. Youngstown will be remembered as the scene of riots early in January, 1916, so the district ran true to form.

The Connellsville coke region was not touched by the strike. The by-product plants at Youngstown were closed, but the Farrell plant remained in operation, and the great Clairton plant operated better than 50 per cent. With so many furnaces banked a surplus of coke developed and Connellsville operations had to run fewer days per week, with a possibility that some ovens would have to be put out entirely. The lake ore boats were able to leave with full crews, but it was not certain that the condition would continue.

As soon as the general scope of the strike could be gaged with some accuracy the conclusion was reached that the question whether the strike would grow or diminish would be determined by the Monongahela Valley. That valley did not escape altogether, the two independent steel plants at Monessen being closed at the outset and the Braddock and Rankin wire plants within a day or two. The three great Carnegie works, Homestead, Edgar Thomson and Duquesne, however, escaped almost entirely, except for a few blast-furnaces; Clairton operated in part, and the great National Tube Works at McKeesport escaped entirely. It was expected that if the Monongahela Valley could be kept in operation to the extent that obtained the first two days of the strike there would eventually be a yielding of the strikers at Youngstown and then a yielding even as far away as Gary and Chicago. At this writing the prospects are that the Monongahela Valley will hold. The agitators at once concentrated their efforts on Homestead, but without making any inroads beyond the slight defections that occurred at the outset.

The iron and steel manufacturers held no meetings in advance of the strike and needed none to become of one mind, for the issue was too plain to admit of doubt or debate. It was purely one of surrender of control of the plants to professional agitators. The manufacturers will contest the issue until they have won. How long or how short the contest will be no one has ventured to predict. Professional strike breakers will not be employed. Undoubtedly many of the men who are out are out because of intimidation and the number of such will doubtless grow. There have been numerous clashes between strikers and would-be workers, but the arrangements of State, county and municipal authorities have been extensive and are probably adequate for the preservation of order, though possibly not for the return of men to work, unless such men are very largely in the majority. The time may come when strenuous measures will be necessary to protect men desiring to return to work.

The organization campaign did not produce strike funds, as the small sums collected from those who "joined" would barely pay running expenses. Some of the 24 unions under whose auspices the movement was conducted may have large strike funds, but the money would not be used except to support members of the respective crafts, and thus such funds scarcely count at all. Many of the common laborers, and it is claimed the great majority, are relatively well provided with funds, running into hundreds of dollars apiece. The manufacturers are of course in position to conduct a strike indefinitely, as the time is long past for iron and steel manufacturers to be short term borrowers. The chief hardship, and a very great one, in a prolonged strike, would fall upon the consumers of steel. Many buyers of steel have been quick to advise the steel producers from whom they draw their supplies that they are in full accord with the manufacturers' position and will uncomplainingly submit to any hardships the situation imposes.

The Chemical Market

New York, September 22.

Business in this market, on the whole, is good; in some branches it is excellent. Belonging in the latter class are industrial chemicals and coal-tar intermediates. While the sagging condition of foreign exchange has had a deterrent effect on export trading, business of proportions yet emanates from that source. Fairly representative of conditions in the chemical field is the statement of an important manufacturer that last month was the biggest month he has had in two years, and that he is sold ahead for the next two months on practically all his products. As against the weakness in crude rubber and naval stores, the vegetable oil market is apparently becoming stronger, due to the fact that speculative interests are now buying to cover previous losses, while soap manufacturers have run low in supplies and are anxious buyers.

The influenza scare which is sweeping the country again is having the effect of bringing out very strong demands for *formaldehyde*, which is held at 22c. per lb. minimum. Leading makers are sold in advance four weeks to two months. There is also a sizable outlet through export channels.

There being a present slight shortage of *aqua ammonia*, with demand increased, a strengthening inclination is apparent, although no change in price has been announced.

Demand for *salt cake* (*sodium sulphate*) has not diminished since the last review. With several producers having their output for the remainder of the year taken, there is a slight shortage. One manufacturer has advanced the quotation to $21 per ton, but this increase is by no means general.

Unabated demand keeps the heavy acids, particularly *muriatic* (*hydrochloric*), in short supply. South America and Cuba have been buying heavily of these acids for some time, as well as *aluminum sulphate*. Lack of demand, on the other hand, has sent *tartaric acid* down to 79½c. per lb. from 84-86c. An export interest in *picric acid* has sprung up recently with the Far East and South America the principal buyers.

The majority of producers are allotting only small quantities of *barium chloride* to their customers, this being another of the chemicals whose production is covered—in some cases to the end of the year—by advance sales.

Similarly affected by the conditions of shortage and demand are *sodium nitrate*, *sodium prussiate, yellow*, both the red and yellow varieties of *potassium prussiate*, *alcohol* and *refined gum camphor*. On practically all of these items manufacturers are behind in deliveries. Gum camphor has received a sharp advance of 10c. per lb., to $3.30, with the bigger interests seemingly having dropped out of the market.

Manufacturers are still holding *sodium bichromate* at 15c. per lb., although now and then a few lots are offered at 14¼-14½c.

Coal-Tar Products

Some manufacturers of coal-tar intermediates, having their production for the remainder of the year already sold, are busying themselves with placing contracts for next year. Still the prominent feature of this market is aniline oil. It is very scarce at 32c. per lb. for spot, an advance of 2c. over the bottom selling figure two weeks ago. Future deliveries into next year are offered at 26c. Aniline salt is in the same strong position with spot material quoted at 35c. minimum, in comparison with 28c. which obtained at the last writing.

The Government restriction on the export of its surplus phenol, together with the cost entailed in re-working material purchased from this source, has led to an advance by manufacturers to 15-16c. in drums for the U. S. P. grade.

Metol, a photographic developer, is again on the market, selling at $11 per lb. It is another of the German-made products on which chemists have been experimenting during the war and which now can be produced in sufficient quantity for commercial use.

Vegetable Oils

Domestic business is holding most of the interest in vegetable oils, the bulk of the buying coming from speculative interests and soap manufacturers. Export commerce shows some improvement and is only awaiting exchange adjustments before accruing to former proportions. Germany and Austria are negotiating for large quantities of vegetable oils through indirect sources.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, SEPT. 23, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	......-......	$0.55 -$0.60
Acetone	lb.	$0.13½-$0.14	.15 - .15½
Acid, acetic, 28 per cent	cwt.	2.50 - 3.00	3.00 - 3.25
Acetic, 56 per cent	cwt.	5.00 - 5.50	6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00 -12.50	12.90 -13.50
Boric, crystals	lb.	.13 - .13½	.13½- .14
Boric, powder	lb.	.13 - .13½	.13½- .14
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	1.50 - 1.75	2.00 - 2.50
Hydrofluoric, 52 deg	lb.	.10 -......	.11 -......
Lactic, 44 per cent. tech	lb.	.11 - .14	.12 - .16
Lactic, 22 per cent. tech	lb.	.05 - .06	.05½- .07
Molybdic, C. P.	lb.	......-......	4.00 - 4.25
Nitric, 40 deg	lb.	.06 - .06½	.07 - .08½
Nitric, 42 deg	lb.	.07 - .07½	.08 -......
Oxalic, crystals	lb.	.23 - .25	.25 - .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 -......	.10 - .14
Picric	lb.	.30 - .35	.40 - .50
Pyrogallic, resublimed	lb.	......-......	2.30 - 2.55
Sulphuric, 60 deg., tank cars	ton	12.00 -16.00	......-......
Sulphuric, 60 deg., drums	ton	17.00 -......	22.00 -......
Sulphuric, 60 deg., carboys	ton	20.00 -......	25.00 -......
Sulphuric, 66 deg., tank cars	ton	17.00 -18.00	22.00 -23.00
Sulphuric, 66 deg., drums	ton	20.00 -21.00	25.00 -26.00
Sulphuric, 66 deg., carboys	ton	25.00 -......	30.00 -40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 -......	27.00 -......
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 -......	32.00 -......
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 -......	35.00 -......
Tannic, U. S. P.	lb.	......-......	1.35 - 1.45
Tannic (tech.)	lb.	......-......	.42 - .55
Tartaric, crystals	lb.	......-......	.79½- .86
Tungstic, per lb. of WO	lb.	......-......	1.20 - 1.40
Alcohol, Ethyl	gal.	4.75 -......	4.90 -......
Alcohol, Methyl	gal.	1.30 -......	1.33 - 1.38
Alcohol, denatured, 188 proof	gal.	.52 -......	.54 - .55
Alcohol, denatured, 190 proof	gal.	.46 - .48	.50 - .51
Alum, ammonia lump	lb.	.03½- .04½	.04½- .04½
Alum, potash lump	lb.	.08 - .08½	.09 - .09½
Alum, chrome lump	lb.	.15 - .16	.18 - .20
Aluminum sulphate, commercial	lb.	.01½- .02	.02½- .02½
Aluminum sulphate, iron free	lb.	.02½- .03	.03½- .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 -......	.08 - .08½
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	......-......	.30 - .35
Ammonium carbonate, powder	lb.	.13 - .13½	.14 - .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½- .13	.13½- .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 - .12½	.13 - .13½
Ammonium nitrate	lb.	.10 -......	.11 - .12
Ammonium sulphate	lb.	.05 -......	.06 -......
Amyl acetate	gal.	......-......	3.75 - 4.00
Arsenic, oxide, lumps (white arsenic)	lb.	......-......	.09 - .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	......-......	......-......
Barium chloride	ton	75.00 -80.00	85.00 -90.00
Barium dioxide (peroxide)	lb.	.22 -......	.24 -......
Barium nitrate	lb.	.10 - .10½	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.02½- .03	.03½- .04
Bleaching powder (see calcium hypochlorite)		......-......	......-......
Blue Vitriol (see copper sulphate)		......-......	......-......
Borax (see sodium borate)		......-......	......-......
Brimstone (see sulphur, roll)		......-......	......-......
Bromine	lb.	......-......	.65 - .75
Calcium acetate	cwt.	2.00 - 2.05	2.10 -......
Calcium carbide	lb.	......-......	.04 - .05
Calcium chloride, fused, lump	ton	19.00 -25.00	30.00 -40.00
Calcium chloride, granulated	lb.	.01½- .01½	.02 - .02½
Calcium hypochlorite (bleaching powder)	cwt.	2.00 - 2.25	2.50 -......
Calcium peroxide	lb.	......-......	1.50 - 1.70
Calcium phosphate, monobasic	lb.	......-......	.75 -......
Calcium sulphate, precipitated	lb.	......-......	.09 - .09½
Carbon bisulphide	lb.	.05½-......	.06 -......
Carbon tetrachloride, drums	lb.	.10 - .11	.12 - .14
Carbonyl chloride (phosgene)	lb.	......-......	.75 -......
Caustic potash (see potassium hydroxide)		......-......	......-......
Caustic soda (see sodium hydroxide)		......-......	......-......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 - .05½	.08 -......
Cobalt oxide	lb.	......-......	1.00 - 1.65
Copperas (see iron sulphate)		......-......	......-......
Copper carbonate, green precipitate	lb.	......-......	.28 - .31
Copper cyanide	lb.	......-......	.65 - .70
Copper sulphate, crystals	lb.	.08½- .08½	.09 - .09½
Cream of tartar (see potassium bitartrate)		......-......	......-......
Epsom salt (see magnesium sulphate)		......-......	......-......
Formaldehyde, 40 per cent	lb.	......-......	.20 - .22½
Glauber's salt (see sodium sulphate)		......-......	......-......
Glycerine	lb.	......-......	.19 - .21
Iodine, resublimed	lb.	......-......	4.50 -......
Iron oxide, red	lb.	......-......	.03 - .20
Iron sulphate, (copperas)	cwt.	1.00 -......	1.20 - 1.50
Lead acetate, normal	lb.	......-......	.12½- .14½
Lead arsenate (paste)	lb.	......-......	.13 - .17
Lead nitrate, crystals	lb.	......-......	.85 - .86½
Litharge	lb.	......-......	.09½- .10½
Lithium Carbonate	lb.	......-......	1.50 -......
Magnesium carbonate, technical	lb.	......-......	.13 - .14½
Magnesium sulphate, U. S. P.	100 lb.	2.00 - 2.63	2.75 - 3.00
Magnesium sulphate, commercial	100 lb.	1.75 -......	2.00 - 2.50
Nickel salt, double	lb.	.14 -......	.15 -......
Nickel salt, single	lb.	.12 -......	.15 - .16
Phosgene (see carbonyl chloride)		......-......	......-......
Phosphorus, red	lb.	......-......	.60 - .70
Phosphorus, yellow	lb.	......-......	.35 - .37
Potassium bichromate	lb.	.25 - .28	.30 -......
Potassium bitartrate (cream of Tartar)	lb.	......-......	.55 - .60
Potassium bromide, granular	lb.	......-......	.49 - .50
Potassium carbonate, U. S. P.	lb.	.60 -......	.65 - .70
Potassium carbonate, crude	lb.	.19 -......	.21 -......
Potassium chlorate, crystals	lb.	.20 - .24	.25 - .30
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.30 - .32	.35 - .40
Potassium iodide	lb.	......-......	3.55 - 3.60
Potassium nitrate	lb.	.19 -......	.21 -......
Potassium permanganate	lb.	......-......	.55 - .65
Potassium prussiate, red	lb.	......-......	1.05 - 1.15
Potassium prussiate, yellow	lb.	......-......	.50 - .60
Potassium sulphate	ton	225.00 -......	......-......
Rochelle salts (see sodium potas. tartrate)		......-......	......-......
Salammoniac (see ammonium chloride)		......-......	......-......
Sal soda (see sodium carbonate)		......-......	......-......
Salt cake (sodium sulphate)	ton	17.00 -21.00	......-......
Silver cyanide	oz.	......-......	1.19 -......
Silver nitrate	oz.	......-......	.69½- .70½
Soda ash, light	100 lb.	1.90 - 2.00	2.10 - 2.25
Soda ash, dense	100 lb.	2.25 -......	2.50 - 2.75
Sodium acetate	lb.	.05½- .06½	.07 - .08
Sodium bicarbonate	100 lb.	2.35 -......	2.75 - 3.00
Sodium bichromate	lb.	.14½- .14½	.15 - .16
Sodium bisulphate (nitre cake)	ton	3.00 - 8.00	10.00 -......
Sodium bisulphite	cwt.	1.80 - 1.90	2.00 - 2.10
Sodium borate (borax)	lb.	.07½-......	.08 - .08½
Sodium carbonate (sal soda)	100 lb.	1.35 - 1.50	1.50 - 1.75
Sodium chlorate	lb.	.15 -......	.16 - .18½
Sodium cyanide	lb.	.30 -......	.31 - .34
Sodium fluoride	lb.	.13 -......	.14 - .15
Sodium hydroxide (caustic soda)	100 lb.	2.75 -......	2.90 - 3.50
Sodium molybdate	lb.	2.50 -......	3.25 -......
Sodium nitrate	100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	.09½- .10	.10½- .13
Sodium peroxide, powdered	lb.	......-......	.30 - .32
Sodium phosphate, dibasic	lb.	.03½- .04	.04½- .05
Sodium potassium tartrate (Rochelle salts)	lb.	......-......	.43 - .45½
Sodium prussiate, yellow	lb.	.17½- .18½	.19 - .20
Sodium silicate, solution (40 deg.)	lb.	.01½- .02	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	.02½- .03	.03½- .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.05 - 1.35	1.50 - 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	......-......	.05 - .06
Sodium sulphite, crystals	lb.	.03½-......	.04 - .06
Strontium nitrate, crystals	lb.	.25 -......	.28 -......
Sulphur chloride	lb.	.05½-......	.06 -......
Sulphur, crude	ton	22.00 -......	......-......
Sulphur dioxide, liquid, cylinders	lb.	......-......	.10 - .12
Sulphur (sublimed), flour	100 lb.	3.10 -......	3.40 - 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 -......	3.15 - 3.40
Tin bichloride (stannous)	lb.	.44 -......	.46 - .50
Tin oxide	lb.	......-......	.60 -......
Zinc carbonate, precipitate	lb.	......-......	.20 -......
Zinc chloride, gran.	lb.	.12½-......	.13½- .14
Zinc cyanide	lb.	.49 -......	.58 -......
Zinc dust	lb.	.09 - .11	.11 - .14
Zinc oxide, dry American	lb.	......-......	.09 - .15
Zinc sulphate	lb.	.03½- .03½	.04 - .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	— $1.10
Alpha naphthol, refined	lb.	1.40	— 1.50
Alpha naphthylamine	lb.	.32	— .50
Aniline oil, drums extra	lb.	.32	— .33
Aniline salts	lb.	.32	— .35
Anthracine, 80% in drums (100 lb.)	lb.	.90	— 1.00
Benzaldehyde (f.f.c.)	lb.	1.00	— 1.15
Benzidine, base	lb.	1.00	— 1.25
Benzidine, sulphate	lb.	1.00	— 1.15
Benzoic acid, U. S. P.	lb.	.90	— 1.10
Benzoate of soda, U. S. P.	lb.	.85	— 1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.25	— .29
Benzol, 90%, in drums (100 lb.)	gal.	.24	— .28
Benzyl chloride, 95-97%, refined	lb.	.35	— .40
Benzyl chloride, tech	lb.	.25	— .35
Beta naphthol benzoate	lb.	3.75	— 4.50
Beta naphthol, sublimed	lb.	.75	— .80
Beta naphthol, tech	lb.	.45	— .55
Beta naphthylamine, sublimed	lb.	2.25	— 2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.10	— .....
Ortho-cresol, in drums (100 lb.)	lb.	.20	— .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85	— .90
Cresylic acid, 95-97%, dark, in drums	gal.	.80	— .85
Cresylic acid, 50%, first quality, drums	gal.	.60	— .....
Dichlorbenzol	lb.	.07	— .10
Diethylaniline	lb.	1.40	— 2.25
Dimethylaniline	lb.	.55	— .60
Dinitrobenzol	lb.	.26	— .37
Dinitroclorbenzol	lb.	.25	— .30
Dinitronaphthaline	lb.	.45	— .55
Dinitrophenol	lb.	.33	— .36
Dinitrotoluol	lb.	.30	— .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	— .65
Diphenylamine	lb.	.58	— .75
H-acid	lb.	1.60	— 1.75
Metaphenylenediamine	lb.	1.15	— 1.80
Monochlorbenzol	lb.	.12	— .15
Monoethylaniline	lb.	1.50	— 1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	— .08
Naphthaline, flake	lb.	.06½	— .07½
Naphthaline, balls	lb.	.08½	— .10
Naphthionic acid, crude	lb.	.75	— 1.25
Nitrobenzol	lb.	.14	— .19
Nitro-naphthaline	lb.	.35	— .45
Nitro-toluol	lb.	.17	— .20
Ortho-amidophenol	lb.	3.75	— 4.25
Ortho-dichlor-benzol	lb.	.15	— .20
Ortho-nitro-phenol	lb.	.90	— 1.25
Ortho-nitro-toluol	lb.	.25	— .40
Ortho-toluidine	lb.	.30	— .45
Para-amidophenol, base	lb.	2.60	— 3.50
Para-amidophenol, HCl	lb.	2.75	— 3.25
Para-dichlor-benzol	lb.	.15	— .18
Paranitraniline	lb.	.95	— 1.10
Para-nitro-toluol	lb.	1.35	— 1.80
Paraphenylenediamine	lb.	2.50	— 4.00
Paratoluidine	lb.	1.50	— 2.50
Phthalic anhydride	lb.	1.50	— 2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	— .15
Pyridin	gal.	2.50	— .....
Resorcin, technical	lb.	3.50	— 3.75
Resorcin, pure	lb.	6.50	— 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.35	— .40
Salicylic acid, U. S. P.	lb.	.45	— .48
Salol	lb.	.85	— .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.20	— .27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.18	— .24
Sulphanilic acid, crude	lb.	.25	— .30

Tolidine	lb.	$1.70	—	$2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.26	—	.....
Toluol, in drums	gal.	.30	—	.....
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.23	—	.27
Xylol, commercial, in tank cars	gal.	.22	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.44	—	$0.45
Beeswax, refined, yellow	lb.	.48	—	.49
Beeswax, white pure	lb.	.65	—	.68
Carnauba, No. 1	lb.	.85	—	.88
Carnauba, No. 2, regular	lb.	.65	—	.80
Carnauba, No. 3, North Country	lb.	.50	—	.52
Japan	lb.	.18½	—	.19½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	.....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.06	—	.06½
Paraffine waxes, refined, 118-120 m.p.	lb.	.07¾	—	.08
Paraffine waxes, refined, 128-130 m.p.	lb.	.09	—	.09½
Paraffine waxes, refined, 133-135 m.p.	lb.	.11	—	.11½
Paraffine waxes, refined, 135-137 m.p.	lb.	.12½	—	.13½
Stearic acid, single pressed	lb.	.25	—	.26
Stearic acid, double pressed	lb.	.27	—	.28
Stearic acid, triple pressed	lb.	.30	—	.33

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.05
Pine oil, pure, dest. dist.	gal.	96
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.34
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.85
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.30
Pinewood creosote, ref.	gal.	.48

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$16.80	—	$18.25
Rosin E-I	280 lb.	18.50	—	20.75
Rosin K-N	280 lb.	21.00	—	24.00
Rosin W. G.-W. W.	280 lb.	24.50	—	25.25
Wood rosin, bbl.	280 lb	17.00	—	18.25
Spirits of turpentine	gal.	1.73	—	1.75
Wood turpentine, steam dist.	gal.	1.68	—	.....
Wood turpentine, dest. dist.	gal.	1.50	—	.....
Pine tar pitch, bbl.	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	13.50	—	13.75
Retort tar, bbl.	280 lb.	14.25	—	14.75
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.95	—	1.07
Rosin oil, fourth run	gal.	1.05	—	1.10

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.54	—	.....
Upriver coarse	lb.	.32	—	.32½
Upriver caucho ball	lb.	.32	—	.....
Plantation—First latex crepe	lb.	.49	—	.50
Ribbed smoked sheets	lb.	.48	—	.49
Brown crepe, thin, clean	lb.	.45	—	.46
Amber crepe No. 1	lb.	.46	—	.47

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.19
Castor oil, AA, in bbls.	lb.	.21	—	.22
China wood oil, in bbls.	lb.	.22½	—	.23
Cocoanut oil, Ceylon grade, in bbls.	lb.	.17½	—	.18½
Cocoanut oil, Cochin grade, in bbls.	lb.	.19½	—	.20
Corn oil, crude, in bbls.	lb.	.20	—	.23
Cottonseed oil, crude (f.o.b. mill)	lb.	.16	—	.20
Cottonseed oil, summer yellow	lb.	.23½	—	.26
Cottonseed oil, winter yellow	lb.	.24½	—	.27
Linseed oil, raw, car lots	gal.	2.08	—	2.12
Linseed oil, raw, tank cars	gal.	2.08	—	2.10
Linseed oil, boiled, car lots	gal.	2.00	—	2.14
Olive oil, commercial	gal.	2.30	—	2.50
Palm, Lagos	lb.	.17	—	.17½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16	—	.17
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.19½	—	.22
Peanut oil, refined, in bbls.	lb.	.27	—	.28
Rapeseed oil, refined in bbls.	gal.	1.50	—	1.60
Rapeseed oil, blown, in bbls.	gal.	1.57	—	1.70
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.17	—	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.14	—	.15

FISH

Winter pressed Menhaden	gal.	$1.28	—	.....
Yellow bleached Menhaden	gal.	1.30	—	$1.31
White bleached Menhaden	gal.	1.32	—	.....
Blown Menhaden	gal.	1.34	—	1.38

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00	—	$36.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	35.00	—	47.50
Casein	lb.	.16	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	$ .04	—	$ .05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	11.50	—	16.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	$30.00	—	$35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	30.00	—	40.00
Fuller's earth, imported, powdered	ton	.....	—	.....
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	1.10	—	1.15
Shellac, D. C.	lb.	.....	—	.....
Shellac, V. S. O.	lb.	.....	—	.....
Shellac, Diamond I.	lb.	.....	—	.....
Shellac, orange, fine	lb.	.....	—	.....
Shellac, orange, superfine	lb.	1.20	—	1.30
Shellac, A.C. garnet	lb.	.....	—	.....
Shellac, bleached, bone dry	lb.	1.30	—	....
Shellac, bleached, fresh ground	lb.	1.20	—	.....
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	55.00	—	60.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	net ton	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.30	—	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70	—	.....
Ferro-manganese, 70-80% Mn	gross ton	105.00	—	115.00
Spiegeleisen, 16-20% Mn	gross ton	35.00	—	36.00
Ferro-molydenum, per lb. of Mo	lb.	2.50	—	3.00
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	—	1 40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, C_2O_3	unit	$0.60	—	$0.80
Chrome ore, 48% and over	unit	.90	—	1.00
Coke, foundry, f.o.b. ovens	net ton	5.50	—	6.00
Coke, furnace, f.o.b. ovens	net ton	4.00	—	5.00
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines	net ton	20.00	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	.....	—	.....
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.13	—	.....
Pyrites, foreign, fine	unit	.13	—	.....
Pyrites, domestic, fine	unit	.14	—	.17½
Ilmenite, 52% TiO_2, f.o.b. N. Y.	net ton	40.00	—	.....
Rutile, 95% TiO_2, f.o.b. N. Y.	net ton	200.00	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free, f.o.b. N. Y.	net ton	135.00	—	.....
Monazite, per unit of ThO_2, f.o.b. N. Y.	unit	42.00	—	.....

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	15.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	55.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	43.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	60.00-70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	2.15
Linseed oil, 5 gal. cans	gal.	2.30
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.65
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

CHEMICAL
& METALLURGICAL
ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, October 8, 1919 Number 8

Views on Potash: A Point of Time

IN THE pages devoted to "Readers' Views and Comments" we are glad to print a communication from FREDERICK W. BROWN, commenting on the editorial entitled "Does American Potash Need a Fixed Price?" appearing on page 220 of the issue for Sept. 1. Mr. BROWN writes as the executive secretary of an association of nearly all the American producers, and his opinions bear special weight when it is known that during the war he, as a member of the Department of Agriculture's technical staff, investigated in detail the sources of fertilizer supply and the fields of American consumption. His statement is worthy of special emphasis: "The American producers quite agree with your claims that with correct technology they will be able to compete [with foreign importations] but," he adds, "they claim, with justice, in my opinion, that they must have a brief time to install equipment which shall be technically correct, and time to reduce somewhat the excessive capital investment which now stands against the plants."

Apparently, the only important point of difference between the responsible officers of the United States Potash Producers' Association and CHEMICAL & METALLURGICAL ENGINEERING is that of *time*. They say the industry needs "a limited and temporary protection" of "two years as an irreducible minimum." On the other hand, we have stated that "the American potash industry can stand on its own feet, and can now compete with foreign importations."

It has now been nearly a year since the Armistice was signed, since war ceased. During that time many American producers have been temporarily idle, owing to inability to sell their accumulated stocks, but these have practically all been disposed of within the past few months at a price ranging close to $2.25 per unit. During that time about 8000 tons K_2O have been imported from French sources, and have been sold at from $1.50 to $1.70 per unit. Compared to the actual needs of the country—doubtless 300,000 tons K_2O—this amount of Alsatian potash is so small that its effect on the price of the meager American supply should have been small indeed. Actually, it did have a profound psychological effect, since the purchasers of potash affected to believe they would get an immense amount of cheap foreign potash immediately, and advertised this idea in order to get local potash at an unduly low price, judged by the relation of supplies to requirements.

Thus a year has passed without ruinous competition from abroad. An acute shortage of potash still exists, and famine prices should rule. As for the future, even the optimistic statement of Dr. GALE of the Geological Survey that there may be available during the next 12 months 50,000 tons of pure potash from Alsace and an equal quantity from Germany should not cause American producers to throw up their hands in despair. Germany and France are both so poor that it is inconceivable but that they will try to get as much for their exports as the market will pay. Their costs have largely increased, corresponding to the general inflation of prices the world over, and even with the maximum production from American sources, there will still be available less than two-thirds the amount which could economically be used in America. All of these facts point to a relatively high return for local potash for at least another year.

Here are the two years asked for by the best of the American plants. We are of the opinion, therefore, that potash men in the United States have been given and will still have months of breathing space in which to reorganize and stabilize their finances, and to perfect their processes. This period results from the operation of slow-moving world-wide economic conditions rather than unstable national restrictive legislation. A wise man grasps his opportunities, and makes the most of them.

The Sorry Plight of Our Educational Institutions

EMERGING from the war period and attempting to resume their pre-war activities, American colleges and universities find themselves seriously handicapped for funds with which to meet the increased cost of conducting their business. Most of them have fixed incomes, either from endowment or the State; and the problem of increasing their resources is made difficult by awaiting benefactions and bequests in the first instance, or tardy action by State legislatures in the second. In either event, expansion is retarded, salaries remain so unattractively low as to fail to hold good men on the faculties, and the authorities are confronted with the prospect of a stagnation worse than dissolution.

Harvard and the Massachusetts Institute of Technology have undertaken to raise additional endowment funds among their alumni and friends. There are other similar movements, and we welcome the opportunity to approve the general campaign for the decent support of our schools and educators. The latter are notoriously underpaid. They doubtless expect to forego affluence and luxury, living simply and in contentment, but at the present time they are paying too high a price for their mental and spiritual advantages. The hod-carrier and the window-washer, to say nothing of that modern MIDAS, the ship-riveter, so far outstrip the poor professor in wages as to gain for him more sympathy than usual. It is not difficult to prove quite logically that teachers would all have higher salaries if their pay were commensurate with the required ability to fill their positions and the responsibility devolving upon them and their labors. They deserve better of the public; but instead of striking they merely resign and get a more remunerative, if less attractive, job. One of the most important features of the Harvard and "Tech" plans for new endowment is an increase in faculty salaries to respectable proportions. For this, if nothing more, the movement is commendable.

Welfare Work or Manpower Engineering

HERE is a dictum on "Welfare or Manpower Engineering" which was lately published in the *National Efficiency Quarterly*:

"Exit welfare work; built upon benevolence, fostered by generosity and supervised by industrial missionaries. Enter manpower engineering; established on identity of interest and charged to operating costs."

It feels good to deliver an aphorism, and we've no doubt that the author of the two above sentences has enjoyed life in augmented measure since they were first uttered. But this "exit welfare work" and "enter manpower engineering" worries us a little. If we don't look out we are likely to run amuck on the subject of engineering, and to think that it means what it does not. Engineering has to do with the science of making and using engines and machines and with such designing of works as requires special knowledge of materials, machinery and the laws of mechanics. That is substantially the definition of the Standard Dictionary, and we think it a better one than a number of all-encompassing and braggadocio definitions that have lately been going the rounds.

Manpower is exercised by the man himself, and not by his boss. We must remember that. If the man who exchanges his power for wages is to exercise judgment in the functioning of this attribute, then he becomes the engineer of his manpower, and his boss becomes the engineer of his judgment—which is stretching the concept of engineering too far. If we use the word in this sense, then the mother becomes a family engineer when she sends for the doctor to visit her sick child. And the physician becomes a nutrition engineer when he prescribes lime water to be added to the child's milk. And if we are all to get aboard the engineers' band wagon, then the writer of these lines, who is a testy old party, will put in his claim for classification as a script engineer.

Nobody likes welfare work that is designed to make him over according to the judgment of somebody else. This may be the reason why boys are ever in collusion against the schoolmaster. He wants to improve their minds by so many lines of Virgil's Æneid, and they want to quicken their faculties on the baseball diamond. Everybody wants to be free to use his judgment, whether he has any or not. It is out of this desire that all our songs of freedom are born. But we can't get away from welfare work. We may have to give it another name, because so many disagreeable and unpleasant persons have engaged in it, but no conscientious employer can dispense with it. Every decent man is engaged in welfare work among his neighbors when he tries to make the neighborhood agreeable and pleasant. This is equally true of the rich and of the poor. Welfare work is co-operative; it isn't patronage, although it must be benevolent.

We are obliged to maintain welfare work, and it should be built on benevolence. It is a mistake to think that a man must wear white whiskers and be rich and arrogant to be benevolent. Indeed he cannot be benevolent if he is arrogant. Benevolence indicates kindliness of heart, and if employers are to forego the practice of benevolence in its true sense, a bolshevik rule is the best that they can expect or even deserve. And unless welfare work is fostered by generosity it will be too uncomfortable to endure. Good housing conditions in isolated manufacturing villages are part of welfare work, and if laborers' houses are built by a mean man the laborers' family life is spoiled. Generosity is essential.

If the "industrial missionaries" who are said to have supervised welfare work are efficiency engineers, we think the point well taken. They cannot solve the labor problem. If they are snobs of any description, the point is also well taken. But if they are wise and conscientious employment managers and district nurses and men and women who understand that the flowering of welfare work and benevolence and generosity is in co-operation, then we think that they are the only kind of persons who can supervise it.

Now let us consider the second sentence: "Enter manpower engineering." We do not believe there is any such thing. There might be slavepower engineering, but manpower engineering is impossible in a free country. Granted for the sake of argument, however, that it is possible, then it cannot be established upon identity of interest, because, if a man's judgment is not permitted to function he is playing a losing part despite high wages—unless he is a moron, in which case he should not receive high wages.

The idea of charging things to operating expenses is well established. Operating expenses are like the commercial traveler's expense account, and sometimes they carry a considerable burden, especially the burdens of error. We know of financially successful establishments surrounded by dirty, tumble-down tenements with bad Americans in the making in them due to lack of welfare work, rather than to low wages. In these instances the operating costs have been underladen—unless there were errors of judgment to boost them. But high operating expenses do not indicate good labor conditions any more than a high expense account indicates a good salesman. We do not think the second postulate in regard to the triumphal entry of manpower engineering established on identity of interest and charged to operating costs is illuminating. We're sorry to say that we can't see that it points toward greater enlightenment. It is not the key to the labor problem.

We wish the English language were held in higher esteem than it is, and that it were used with greater discrimination.

Readers' Views and Comments

Does American Potash Need a Fixed Price?

To the Editor of Chemical & Metallurgical Engineering

SIR:—The editorial "Does American Potash Need a Fixed Price?" in your Sept. 1 number has come to my attention. Will you permit me to point out certain facts which I think the writer of the article has overlooked?

In the first place, the American potash producers were not responsible for the schedule of maximum prices included in the bill now before the Ways and Means Committee of Congress. The original bill as drawn by the Department of the Interior and introduced in the Senate during the preceding Congress did not contain any such provision. The maximum prices were inserted by the Senate Committee on Mines and Mining, and were included in the present bill only because of the insistence of members of that committee. The potash producers have always feared that the inclusion of this schedule of maximum prices would tend to prejudice their just and equitable demand for protection from German dumping, and when the Ways and Means Committee of the House, during the recent hearings on the bill, suggested that these prices had better be eliminated from the bill, the attorney for the United States Potash Producers' Association immediately approved the suggestion on behalf of the producers. (Page 222, Hearings before Committee on Ways and Means on H. R. 4870.)

The potash producers have repeatedly stated that all they need is a brief period of protection to make the readjustments incidental to changed conditions. This period they have placed at five years at the outside and two years as an irreducible minimum. The better and more up-to-date plants can probably do with two years. On the other hand, some of the smaller plants will doubtless be unable to reach a competing status in five years. But the point to be marked is that the industry asks only a limited and temporary protection, and the producers firmly believe that with such a brief period of safeguarding they can put their plants in a position to compete in the open market with any potash sources on earth.

The reduction of costs to be effected during this temporary period of protection fall under two heads: First, amortization, including obsolescence. Built under war conditions, practically all American potash plants now represent a very heavy construction cost. In addition, since quick production of large tonnage was urgently demanded by the situation of the country and by the insistence of Government officials, large sums were spent on machinery and equipment of an experimental nature but on a commercial-sized scale. In other words, there was no time for elaborate laboratory and semi-commercial tests. As a result, equipment representing large sums has been scrapped and stands on the books today as a dead loss. Quick amortization of part of this excessive construction cost and cost of obsolescent equipment is essential to put the companies on a sound operating basis, and is a just and necessary charge against the product. Figures for amortization in two years were included in the estimates submitted to Congress at the express urging of the War Industries Board. Second, improvements in operating practice. During the war the one essential thing was to get out a tonnage of potash. Reduction of costs both by refinements in operating methods and by development of by-products was a secondary matter and in fact received very little attention. With the passing of the war conditions such reductions of cost became of course of the first importance and are receiving the most earnest thought from American producers.

Two considerations operate against the possibility of effecting such reductions over night. In the first place, it takes time to devise, secure, install and shake down new machinery and labor saving devices to smooth operating conditions. It takes time to determine the possible by-products in raw materials, devise methods of recovery and arrange for marketing such by-products. In the second place, without a reasonable assurance of permanence for the industry, such as would be given by the temporary protection asked for, the necessary credit cannot be secured to finance the new installations and improvements.

Your statement, therefore, that "the American industry can stand on its own feet and can now compete with foreign importations, barring dumping, trade war, rebates and such unfair practices," is not in accord with the facts. The present quotations for foreign potash range from $1.50 to $1.70 a unit. Our producers cannot now meet these prices, but will be able to meet them and possibly lower them in a few years' time if protected from unrestricted European importations during the brief readjustment period. The American producers quite agree with your claims that with correct technology they will be able to compete, but they claim, with justice, in my opinion, that they must have a brief time to install equipment which shall be technically correct, and time to reduce somewhat the excessive capital investment which now stands against the plants.

The preference of the potash producers for a licensing measure instead of a protective tariff is based primarily on the fact that with a license system the consumer will get his potash cheaper than under an adequate tariff. With a license system such part of the country's demand as cannot be supplied by American producers can come in from abroad at a lower price, thus giving the farmer the benefit of cheap foreign potash, while at the same time furnishing American producers with a definite market. With a tariff the price of all potash would be raised to the level of American costs of production, and the American producers fear that such a measure would not secure the final approval necessary to enact it into law. This is set forth on page 79 of the recent hearings on House Bill 4870 before the Ways and Means Committee.

I shall be glad if CHEMICAL & METALLURGICAL ENGINEERING will publish the foregoing statement so that your readers may have the viewpoint of the American potash producers. FREDERICK W. BROWN,

Executive Secretary,

United States Potash Producers' Association.

Washington, D. C.

Willard Gibbs Medal Presented to Dr. William A. Noyes

The Chicago Section of the American Chemical Society presented the Willard Gibbs medal to Dr. William A. Noyes, professor of chemistry in the University of Illinois, at a banquet held in Chicago Sept. 26, 1919. Mr. L. V. Redman, chairman of the Chicago Section, explained the nature and origin of the medal, which is awarded annually by a jury of 12 to an outstanding figure in American chemistry. The award may go to either industrial chemists or those engaged in fundamental research.

Dr. William H. Nichols, president of the society, presented the medal after a short address in which he reviewed the work and character of the recipient. Dr. Noyes spoke informally on the subject of "Positive and Negative Valences," reviewing the development of the various theories and the apparent conflicts that still have to be reconciled before we understand thoroughly the constitution of elements and their compounds. The following brief statement of Dr. Noyes' work, written by Dr. Julius Stieglitz of the University of Chicago, is reproduced from the *Chemical Bulletin*, the lively and efficient organ of the Chicago Section.

DR. WM. A. NOYES

Dr. William A. Noyes is a veteran leader in American chemistry, as teacher, as investigator and as a force in the American Chemical Society, ever working for high ideals and progress. As a teacher, he is most widely known for his textbooks in Qualitative Analysis and Organic Chemistry and his more recent texts in General Chemistry. In all of these books he approaches his subjects with a directness and saneness of thought and method, combining theoretical development and practical material, which make his texts singularly clear and convincing. In his research work he has covered an unusually broad field of subjects: to have done expert work of the highest character in the determination of atomic weights—he received the Nichols medal for his work on the atomic weight of chlorine—as well as extensive and important work in the more complex fields of organic chemistry represents a breadth of knowledge and power which it would be hard to duplicate in any other man, not only in this country, but throughout the world. In recent years, Dr. Noyes has taken active interest in the most important and most absorbing problem of the day, the electronic theories of valence and atomic structure, and has not only contributed ideas deserving of careful consideration, but has also carried out one of the most painstaking investigations looking toward the isolation of simple electromeric compounds, such as $N{-}{-}{-}Cl^{+}$, and $N^{+\,+\,+}Cl^{-}_{3}$. This breadth of chemical interest, combined with a character of sterling honesty and a mind singularly direct and judicial, found one of its most important and happy outlets in the service of Dr. Noyes as Editor of the *Journal of the American Chemical Society*. Through many years, with a unique devotion and self-sacrifice of time and strength, Dr. Noyes brought our major journal to its present high standing among the chemical journals of the world.

All honor is due this modest, productive leader in chemical thought and chemical service to our country.

Production and Exportation of Mercury in Spain

Mercury is produced in the Provinces of Ciudad Real, Granada, and Oviedo, but the most important mines are those of Ciudad Real, which are located at Almaden and cover a surface of 485,187 acres. They are owned and operated by the State.

The Estadistica Minera de España contains some interesting statistics as to the cost of operation of the Almaden mines during the year 1917. In this year excavations were made at 300 sites, at which 2765 cu.m. were excavated at a total labor cost of $97,333. The average daily wage paid was $2.50. The average labor cost per cu.m. was $35.20. The archwork, solid walls and masonry erected for the interior support of the mines cost, for materials and labor, including transportation, timbers used for bracing galleries and shafts, etc., a total of $155,477. Shop expenses for work not let out by contract amounted to $15,931; the various articles classed as accessories cost $81,658, and labor not otherwise specified added $44,498 to the expense.

For labor used in distillation during 1917 the expenditure was $76,132, and for supplies $82,148. Ten pairs of Bustamante subliming furnaces, two Cermak-Spirek, continuous-movement furnaces for fine materials, and three double-pan furnaces of the same system for coarse ores were employed. In the Bustamente furnaces 7550 tons of mineral were treated, from which were produced 984,486 lb. of mercury. In the Spirek system 688,795 lb. of mercury were produced from 5616 tons of ore.

The exports of mercury from Spain for the years 1908 to 1916, inclusive, were:

Year	Lb.	Year	Lb
1908	2,353,629	1913	2,746,386
1909	3,069,959	1914	2,099,978
1910	2,466,935	1915	2,694,394
1911	3,293,392	1916	1,752,538
1912	2,769,085		

A comparison of the figures of output and export shows that practically the entire production is exported—chiefly to Great Britain.

Exposition of Chemical Industries, Chicago

WHILE the doors of the Chicago Coliseum and First Regiment Armory opened on the Fifth Exposition at 12 o'clock noon, Monday, Sept. 22, the formal program ushering in the event was held at 8:20 in the evening of the same day in the auditorium of the Coliseum building, with Mr. Charles F. Roth, Exposition manager, acting as chairman.

The addresses given by men of prominence and high standing in the industrial and chemical world sounded the keynotes on matters vitally interesting to those engaged in the chemical industries and to the general public. The industrial worker can find salvation from present trying conditions, and happiness for us all, in application to his labors and research for our needs. The science of chemistry has found production of additional wealth in by-products from many processes. We must depend on industrial patriotism, and by the use of sound economic principles deliver all from the chaos caused by inapplicable theories and the terminology of vari-defined phrases. The path of the present-day chemist in his progress through the research period is infinitely easier than of old.

Welcome by Dr. Redman

Dr. L. V. Redman, in greeting the visitors, said:

We welcome the Exposition to Chicago as the first to be held in the West, and while it cannot be hoped that it will be held here as frequently as in New York, we wish to persuade the exhibitors that the advantages afforded by this location are fully as great. The exhibits show the marvelous results of five years' intensive research. In chemical discovery mankind has advanced a full generation, bringing with this progress a corresponding rise in the prices of commodities, and these prices are here to stay. We may be something of Bolshevists about our hours of work, but this is only the result of a relaxation after the concentrated effort during the war period, and in a few months such spirit will pass away. Due to this rapid development we now are witnessing perhaps the greatest chemical exposition we shall ever see.

The chemical industry will move its center to the Western field. In 1910 the automobile manufacturing centers were along the Atlantic coast, but now the Middle West holds the greatest output. Chemistry is doing the same thing. Two per cent of all the chemists in the United States have come to Chicago during the last year, and the total number of chemists in this city has increased 25 per cent in number during the same period. Production of meats, cereals, steel, coal tars, dyes, pharmaceuticals is carried on in this locality and the center of production will be here in a short time.

We should observe that the average salary of the chemist has increased from $1200 or $1500 per year to $3000, and while general prices have also risen, the salary increases has been in much greater proportion.

The four qualifications for a good chemist are ability to labor, research, discover and organize. The most remarkable document of the twentieth century, forgetting the League of Nations, was the one drafted by the Federation of Labor and presented to Congress in which it was stated that *the one means by which the workmen can develop better conditions exists in research*, and that Congress should do everything possible to encourage it.

The doctrine has arisen that men believe there is plenty of wealth available for all and that the trouble is not due to distribution but to production. The laborer realizes his hope is in research and is to be congratulated on this point of view. If all the money of all the millionaires were distributed it would keep the country running only two weeks. Therefore, if the laborer keeps the thought of research and production before him he will produce the greatest happiness the country has ever known.

Gov. Lowden's Letter

A letter from Frank O. Lowden, Governor of Illinois, dated Sept. 18 and addressed to Mr. Roth, was read, as follows:

"When I accepted your very much appreciated invitation to address the Fifth National Exposition of Chemical Industries, it was with the qualification that if I were in the State on Sept. 22 and if no unforeseen contingency should arise. It now happens that I have been summoned to appear before the Appropriations Committee of the House of Representatives at Washington to discuss budgetary reform. Perhaps you know that Illinois in 1917 provided the machinery for an executive budget and has since been operating under it very successfully. I therefore feel it my duty to respond to the invitation from Washington and give the Appropriations Committee the results of our experience. I think you will realize that this is one of the most important subjects before the country and that it is my first duty to help Congress in any way I can in this very important matter.

"I wish you would present my greetings to your associates and assure them that I am deeply disappointed because of my inability to welcome this most important body of men to our State. Our people learned during the war the overwhelming importance of chemistry in war. I trust that they may now learn that those connected with the chemical industries can be equally helpful in the beneficent work of reconstruction in times of peace."

Letter of Charles H. Herty

Charles H. Herty, in a letter addressed to Mr. Roth, dated Aug. 28, wrote:

"This morning President Wilson officially authorized me to act for American interests in dye questions abroad. This makes it necessary for me to sail next Wednesday, and I expect to be absent from six to eight weeks. In connection with this matter one of my chief regrets is that this unexpected duty will take me away at the time of the Exposition. I am sure you know how much this grieves me, as I have been present on every occasion heretofore at the opening of the doors, and I regret especially having to miss this particular time in Chicago.

"Will you please convey to Governor Lowden my sincere regret that I shall not have the pleasure of hearing his words of welcome? I know you will be able to find some one who can make more fitting reply than I might have made. I am writing to the chairman of the Chicago Local Section expressing my regrets. Good luck to you, and best wishes for unlimited success to the Fifth Exposition."

Address by Charles F. Roth

Charles F. Roth spoke in part as follows:

"Some few years ago it became our duty to take inventory of our industries to learn our ability to meet the enemy in war. Some months ago it became our function to examine our businesses to their vital parts to know their ability to meet the changed views and demands of the world. Business will not go back to its old methods; the war has taught greater efficiency and its requirements to manufacture all over the world. We must examine into the fundamentals of our operations and, regardless of our present methods, consider the reactions in the processes involved, construct a program and then, comparing it with our present methods, make changes here and there where needed. We must look into the chemistry of our work and methods; its laws are immutable, but they may be made to operate through different channels. Those are the things we must weigh; are our present channels the most efficient?

"Chemistry, today, is playing its most important part in industry and as time goes on will play an ever increasing part; the business that is not founded and administered upon an honest chemical basis, using the most modern and efficient chemical equipment and processes, will be a laggard and failure in the commercial race. American chemical engineering has shown during the past four years its ability to meet all emergencies and the competition of its enemies. There are many manufacturers who do not realize that their organizations and businesses are built upon some chemical truth, that the origin of their business is founded upon some familiar chemical reaction, which, in its many phases, did they know them, would open whole vistas and ranges of thought, new fields and endeavors to them.

CHEMISTRY'S PART IN INDUSTRY

"All the mechanical industries and the arts use or adopt the products of the chemical industries for their purposes. You will further realize upon a moment's reflection that the chemical industries are the wealth-producing industries, for by them the raw and worthless material is converted into a useful and valuable product, the mechanical industries enhance through manufacture by form that which has already been made valuable, the arts give the intrinsic value to some few of the product of the mechanical industries. Humanity adds the sentimental value. There you have the whole gamut of values as they are brought into being. At the fountain head of all this is chemistry. It is the basis of life and industry. Even agricultural pursuits might be counted as a chemical industry, for we soon see that unless the soil is replenished with the constituents removed by the growing plant it becomes unproductive.

"Did all business men sense the value of a chemical study of their processes and place them upon a scientific basis, the result would put our domestic industries in an unassailable position, incomparable with the rest of the world.

"Inquire of the leading firms in every industry for the reason of their leadership. They know that the application of the imperative laws of chemistry to their operation has brought it about. The greatness of Chicago's packing house lies more in the chemical utilization of the waste than the shipping of the prime product. The greatness of the gas house is not in the gas, but in the dyes and pharmaceuticals made from the tar it recovers."

Relation of the Chemist to the Manufacturer

John W. O'Leary, President of the National Metal Trades Association, spoke on "The Relation of the Chemist to the Manufacturer," as follows:

"It is always a pleasure to see and hear loyal Chicagoans, and I thank Dr. Redman for his boost, for his words are true and I believe Chicago will become a big steel center. I am happy that the privilege has been accorded me to participate in the proceedings of this meeting of the National Exposition of Chemical Industries. I had no part in selection of the subject, which permits me to say what I wish.

"I was impressed last week in the East with the fact that we are facing a very critical and serious situation in the United States. I have always tried when thinking in terms of the great war to dwell not so much on its cost in money, in health, sacrifice or supreme loss of life, but more on the gain to the world through the war. It would be unfortunate if we forget the debt we, as survivors of the awful struggle, owe to those who fought the good fight and won for us world liberty. None can do them too much honor, and we would be ingrates indeed if we failed in our daily life and expression to give thanks to God and them for the victory. It seems to me, however, that we would be showing small appreciation and little reverence if we now only devote ourselves to acknowledgment of our debt by erection of monuments, memorials to those who won the war. The cost was too great, the struggle too long, to be content with such expression. We should rather feel the duty ours to honor them by accepting as our task the rebuilding of the world resources destroyed, the conservation of the resources remaining and the preservation of the lessons taught by experience.

OPPORTUNITY FOR CHEMICAL LEADERSHIP

"To you men of the chemical industries comes the opportunity to lead in these tasks. The war brought to all of us a realization of your value in almost every branch of industry. One of the oldest of professions has come into its proper sphere of importance. For, during the war, whether the need was a greater destructive explosive, a more dangerous gas, a more brittle steel, or a more ductile, the science of chemistry was the agency to which we looked. Or if the demands of armies called for more of cloth, or wood, or paper, or leather, or silk, or anything which natural resource or productive capacity could not supply, the chemist was called on to create the substitute.

"And now that we are realizing the effect of interrupted production, and of wholesale destruction, when we are realizing the economic cost, and the difficulty of supplying even our current needs when we know that it is essential that we also restore the lack in these years of war before equilibrium can again exist, what an opportunity is yours to serve the world! The awakening of industry in general to its need for your assistance was marked during the years immediately preceding the war. The twentieth century began with such an appreciation.

"I have been interested all of my life in the steel industry. I have heard my father speak so often of the shipment of steel rails to the United States from England during his early manhood, and of the excitement over the discovery of the bessemer process. I have watched with interest the later development of the open hearth, and the impetus which that development gave to the industry. But it was not until the chemical engineers developed the use of alloys in steel, and the wonderful magic effects of heat treatment, that the full possibilities of the steel industry became apparent. Today the chemistry of steel makes us feel that no matter what phenomenal results have been demonstrated recently, more phenomenal results will occur, and that there is no more important factor in the further development of the steel industry than chemistry.

THE UTILIZATION OF BY-PRODUCTS

"But it is not sufficient that you have improved materially the quality and uses of steel, you have been developing at the same time the by-products, which for so many years were wasted. In so doing, you are making us independent of Germany and her tar compounds and adding materially to the wealth of the United States. It is noticeable that while almost every commodity has increased in price since the armistice, steel has been reduced, and that in spite of higher costs, in actual production of the steel itself. This has been made possible largely through the utilization of the by-products. It is entirely within the realm of possibility that the by-products of steel manufacture may bring profits equal to those of producing steel. Whatever the gain, it will mean much to the future prosperity of the United States.

"Today, we are the only great producing nation in position to carry on normal industry through finance, natural resource and comparative immunity from destruction of life from the war. While we are not taking full advantage of our position, because of industrial strike, we will recover quicker than others. Eventually, however, we must meet competition which will demand the keenest efforts. The farther we advance in utilization of our by-products to carry the cost of manufacture, the better we will meet whatever the balance of the world offers in competition. What has been accomplished in the steel industry is indicative only of the importance of chemistry in almost every basic line. The extravagant, wasteful methods which we employed in the use of our forest resources is forcing attention now. Through the use of preservatives we must conserve what we have left; and it is your province to develop those preservatives.

"The importance of the growth of your industry in the basic chemical field of chemicals, drugs and dyes, is clearly shown in the comparison of our export figures for those articles in 1913 and 1917. Our imports from Germany in 1913 amounted to $21,000,000. Our exports in 1913 to all countries were $30,000,000, while in 1917, partly due to higher prices, but still representing large increase in volume, our exports amounted to $188,000,000. Surely no other American industry can show such a ratio of increase. The war gave both impetus and protection permitting this vast expansion. American initiative, courage, and legislative protection must be forthcoming to continue onward progress. And so I might continue, if time permitted, to enlarge upon the importance of the relationship of chemistry to industry. You know, better than I can tell, how vital your field is to industry. But what of the preservation of industry itself? It seems to me that our industrial progress has for the past year been backward rather than forward, and no gathering of business men at this time should fail to recognize the seriousness of our present trend, and seek for the cause and cure.

"During the war, and more particularly since the armistice, we have been passing through successive stages of higher wage demands, higher profit demands; less hours, less work; more leisure, more extravagance; less responsibility, less patriotism; of course, the result is bringing higher costs, and a progress toward disaster. Economic truths have been discarded for theories which sound well but won't work. We are confused by a plethora of general terms, undefined in our own minds or in the minds of those who utter them. Living wage, collective bargaining, profiteering, labor as a commodity, partnership of capital and labor, the right to organize, shop representation, combination, a new era, democracy in industry, socialization of industry, are some of the terms used each day in every publication; in every forum. *No one attempts to define what is meant, because every one has his own interpretation, and they nearly all differ.*

"The great mass of American workingmen just want to work—the great mass of American employers just want to produce. They both recognize that they are inter-dependent and have co-operative interests, and if permitted to carry on, other conditions will correct themselves. But they too are confused by what is after all nothing more or less than an insiduous Socialistic propaganda. Not that all who are striving to express their understanding of the multitude of new thoughts are Socialists. Many are honest, well meaning folk who have assumed a paternal interest in industry but are in no way responsible for its continuance, nor have they any practical knowledge of its conduct. Others are selfishly interested in the propaganda because it furnishes them their daily bread. Others are employers who either through conscientious belief or pressure have adopted new plans of relationship and are anxious that they not conduct their experiment alone. And industry suffers! *Five months of honest productive effort of American industry will supply all of our own needs, and permit of seven months' effort to replenishment of the world. Yet at our present rate of progress, we are unable to supply our own needs.*

GERMANY'S PRODUCTIVE MAN POWER UNIMPAIRED

"Until recently, all Europe was pursuing similar tactics. Each nation's industry was striving to emulate the progress of Russia under Lenine, who has put into force all of the theories which we are talking about, as he understands them. I do not know whether his interpretation isn't likely to be as correct as any of ours. But today, at least two of the nations who have been passing through this after war orgy are recovering. Belgium is no longer striving to see how few hours she can work, but rather how many hours bodily s ngth and health will permit. Germany, under pre-w con-ditions a wonderful industrial nation, has lost eavily in man power. But before the war 3,500,000 f her men were constantly removed from industry for military purposes, and millions more were engaged in supplying those 3,500,000. Today there is no such drain on her industrial man power and the release of this burden more than offsets her losses during the war. They have stopped talking about the eight, seven or six hour day, and are ready to devote ten, eleven and twelve hours a day to restoring her industrial position.

"Whether or not we are living in a new world, or a new era, the same sun shines, the same God rules. None of the formulas of chemical reaction have changed. We continue to progress in the discovery of new things, but they do not develop over night. Time and honest effort, not laws or theories, will make the discoveries available for service. Progress must be step by step, and each step will succeed only as the proper reagents are used. I remember from my days in chemistry that it required hydrogen and oxygen to produce one of the necessaries of life; that it required two parts of the hydrogen and one of oxygen to accomplish it; either a different element or different proportion meant failure. If we substituted sulphur for the oxygen we made an awful stench. *As I see it, industrial relations operate similarly to chemical relations. To reach proper results we must rely upon employer and employee, and in their proper proportion. Too much power on the part of either will not make the compound desired.* The substitution of another element will make a stench, and the addition of another element will not produce the desired result.

IMPORTANCE OF LABOR CONFERENCE

"Two weeks from today the Labor Conference called by the President of the United States will assemble in Washington. Its importance to industry is emphasized by the request of the President to union labor to await results of the conference before inaugurating further strikes. The corollary is that if results of the conference do not follow the desires of the Federation, strikes will follow, and we must continue the disastrous experiences of the past year. It is important, therefore, to analyze from the President's speeches and trend his views on proper solution. He has expressed his belief that society sanctioned the eight-hour day; he has approved collective bargaining, though not clearly defined as to method; he has said that he would offer a new basis for wages; he has indicated that workmen should be partners in industry; he has advocated placing employees on the boards of directors; he has shown sympathetic approval of the organization of all workers. As I indicated earlier, much depends on the interpretation we give to terms or words. *Under any interpretation, a program based on immediate adoption by American industry of these principles would result in chaos.* Unrest is too keen for the launching of any definite plan of development of theories which, whether good or bad, must be gradual in their presentation; adopted only after experiment in a small way has proved their success, and debated and studied when men are calm and their judgment keen, rather than under hysterical and restless conditions.

INCREASED PRODUCTION THE ONE THING NEEDED

"I hope, therefore, that all men of industry who meet together, whether employer or employee, will consider the seriousness of our industrial future, calmly and without passion, and I hope that as a result of such thought they will express to the President their hope that in this critical period of unrest no radical suggestions be inserted to further complicate conditions. Industry is in no position to absorb further departures from established practice than are now being tried. The general public cannot add to the burden being carried by them. Increased production is the only method which will make permanently possible improved standards of living or working conditions.

"Our greatest need today is for a reawakening of the patriotic impulses created during the war. Now, the slogan should be '*Industrial Patriotism.*' Today we need not so much discussion of rights of capital and labor as two opposing classes, but rather a campaign for industrial patriotism. The war awakened in us a spirit of enthusiasm for country and flag, dormant for many years. The reaction at its close is dissipating a great national asset. Selfishness is reasserting itself. Under the spell of national stress we all labored, not as classes, but as Americans all. The nation is in serious peril if we continue to drift industrially as we have since the armistice. Opportunity invites us, as American citizens, to prosper, and as American citizens, not as classes, we should accept, and fight together for commercial supremacy of the world.

How Long Does It Take to Develop a Laboratory Process Into a Dividend?

Herbert H. Dow, speaking on this subject, said:

"Almost everyone is interested in connecting up his profession with a dividend. LeBlanc, who was the founder of the first chemical process that attained any magnitude, spent about 15 years in building and attempting to perfect a chemical plant for the manufacture of soda ash. During this time the French Revolution impeded his work seriously, and the newness of his ideas made his problems more difficult to solve than those we now encounter in similar work. After spending all these years without attaining his goal, he became discouraged and died by his own hand. About 55 or 60 years later, Ernest Solvay had perfected a laboratory process for the manufacture of soda ash; after spending about 10 years in perfecting the process of manufacture on a large scale, it attained commercial success, and a few years later it became one of the most phenomenally successful processes ever devised. It is very difficult to obtain information in regard to the details of development of these processes that are only known to us through the various publications that have been made from time to time. For this reason I think you will be more interested in hearing of the development of processes that I know more about.

THE BROMINE PROCESS

"The bromine process of the Dow Chemical Co. was first conceived in the summer of 1888. A small commercial plant was built in 1889 at Canton, Ohio. This plant was a commercial failure for a number of reasons, among which were the lack of business experience and also the inadequate supply of raw materials. In the summer of 1890, another commercial plant was erected at Midland, Michigan, using electrolysis instead of chemicals for setting bromine free from its combinations in the brine, and unlike the method then generally employed, it used air instead of steam to blow out the bromine. This plant also was a commercial failure because of many things, among which were the inexperience of the management, and also the fact that the process was a little ahead of the times. I can best explain this last by an illustration:

"We wanted an electric generator having a capacity of 500 amp. at 15 volts. We wrote to all the manufacturers of generators, and most of them that thought a reply to our little concern was worth while stated that 15 volts was too high a voltage, that plating vats had already been tried, connected in series, and found to be a failure, and that 5 or 6 volts was the highest practical limit. True, 120 volts for lighting purposes was standard at that time, but the idea of making 30 or more electrolytic cells and connecting them in series looked like too radical a departure. The manufacturers also said that 500 amp. was too big a current to commutate properly, that it would burn up the commutators in spite of the best design then known. We finally succeeded in buying the type of generator we required and installed the little plant in an old barn. Every part of this plant gave trouble. The generator in particular required constant attention to prevent the commutator and brushes from being burned up, and under the most favorable circumstances the cost of electricity for the commutator attention alone was a large item.

FIRST PLANT A FAILURE

"Finally, in spite of working 18 hours a day, more or less, the plant became a commercial failure, and the company was reorganized with two new partners to supply additional funds. After operating in this way for a few months it became apparent that it would again be a failure, and my first partner, who was a man of successful manufacturing experience, stated that the trouble was that we were trying to operate on too small a scale, with too little capital. We therefore attacked the problem from the financial end, and six or eight months later we began the erection of a relatively large plant. It called for a 50-kw. generator, and in the spring of 1892, I went to Cleveland to purchase this huge dynamo. The man in charge of the General Electric office after a considerable time asked me how large a 50-kw. generator was. Another firm offered to furnish it in three units, saying that it was impossible to run such large units continuously.

FIRST DIVIDEND PAID IN SIX YEARS

"We finally succeeded in buying the generator, and six years from the time we started commercial work we paid our first dividend. This illustrates how the interval of time between the successful laboratory process and the dividend was lengthened by the demands of the process being in advance of the electrical art at that time. More accurately stated, the electricians were too slow for the chemists. If the modern cell had been in existence at that time it would not have been a commercial success, because there were no suitable electric generators, but for the much higher priced bromine, with its higher electrochemical equivalent, the imperfections of the generators were not fatal to the electrolytic process.

"Analysis of the brine we were working on showed that it contained a larger per cent of magnesium chloride than other brines in this country, and we began to do research work with a view to extracting it profitably. About that time I learned that a number of carloads of iron sulphate had been sold for $3 a ton. We found that by precipitating the magnesia from the brine with lime and mixing it with ferrous sulphate and exposing it to the air it would slowly oxidize to ferric hydrate and magnesium sulphate. We decided that the best way to carry out this reaction was to spread the moist mixture of ferrous sulphate and magnesium hydrate on the floor of a long shed and cultivate it with a horse and farm cultivator once a day for several days until it was completely oxidized, and then remove it with a horse and scraper and add a new batch in a similar way. We went so far as to buy some leather boots for the horse but found that they had a very short life owing to the destructive action of the chemicals, and this, together with the difficulty of getting magnesia in the first place free from common salt, caused us to abandon this process.

TEN YEARS DEVELOPING MAGNESIUM CHLORIDE PROCESS

"From time to time other processes for making either magnesium sulphate or chloride were evolved, and tested out in the laboratory, and several of them were tested in a semi-manufacturing plant. Finally, in 1913, one of these semi-manufacturing plants made magnesium chloride in what appeared to be a very satisfactory way, and we therefore started the erection of a large plant. This was completed in August, 1914, a week or two after the war broke out in Europe, and when the Dow Chemical Co. began to sell magnesium chloride in carload lots within 30 days after war was declared, we began to be heralded far and wide in chemical circles as a very progressive firm that was able to get to manufacturing a heavy chemical on a commercial scale in 30 days. In this case, the first dividend was in reality about 10 years after the conception of our farmer process with its horse and cultivator.

"By this time we had a fairly large research and development organization, and practically every chemist in the plant was anxious to get his routine work out of the way so that he could work on some new process. In the fall of 1914 the price of carbolic acid had begun to soar and was attracting the attention of chemists everywhere. One of our organizations conceived the idea that monobrombenzol could be treated in an autoclave with caustic soda with the production of carbolic acid. It was already known that monochlorbenzol would make carbolic acid under these conditions, but the necessary pressure was 3000 lb., more or less, and we knew that the bromide would work at a much lower and more practical pressure. Actual tests showed that a high grade of phenol could be made without exceeding 300 lb. pressure. As this was within the commercial limits for fairly large pieces of apparatus, we immediately began the construction of a small plant.

"About the same time another group of our chemists thought they could make phenol by the process described in the literature. They tested it out in the laboratory and encountered no serious difficulties, and a semi-manufacturing plant was constructed and the various minor difficulties encountered were overcome. Then the price of bromine began to soar, and it became apparent that this process would entail too much investment in bromine to make it practical, so it was dropped and the old method adopted.

SUCCESS OF PHENOL PLANT

"The first plant built had an estimated capacity of one ton per day. It turned out its first product on the first day of November, 1915, and in this 30-day month produced 59,000 lb., which was only 1000 lb. short of the capacity which had been estimated from the small-scale plant. This was the first time in our history that we had gone from a semi-manufacturing plant to a real manufacturing plant without experiencing troubles and months of delay. We attributed our success to a much larger and more mature development organization, and the further fact that after an organization once learns how to develop one chemical manufacturing process, it is much easier to develop another. In this case, the laboratory process and the dividend were less than one year apart, but we must take into consideration that the very abnormal war prices made a profit much more quickly obtainable.

"A high official of one of our largest electrical companies once stated to me that they had to figure on five years from the drafting room to the dividend on any product which was materially different from their normal line. The fact that the United States Government during the war could actually accomplish in six months or a year what an old experienced organization could not accomplish in a much greater length of time can be explained only on the ground that men of very unusual ability, and in much greater numbers than any commercial enterprise could command, were giving their services and the utmost energy which they possessed to the rapid development of these products so urgently needed by the allies. Aside from this fact, in the case of the Government, it was not necessary that costs be reduced to a point which would be essential for a dividend in a private enterprise.

"It is our experience that the method of evolving a successful process is somewhat as follows: The laboratory works out the process and compares it with the state of the art as shown in the literature, and if results would seem to justify the effort to make the process commercial, some further laboratory investigations are carried out, and then the laboratory force, without an exhaustive study of the subject, tests it out in a semi-manufacturing plant, made of commercial materials instead of glass and porcelain. Here a number of new problems will present themselves and will have to be worked out by the research men. After this plant is in successful operation, the draftsmen start their work for a large plant. In the meantime any uncertain points are still being investigated by the research organization, but an exhaustive study of the subject is not made in the research plant, as we have found by experience that there is no limit to the investigations that may be made at this stage, and many of the points which might be worked out would take months of valuable time which could better be employed at other work, even if we take some chances on a process not thoroughly developed. Finally, when the commercial plant begins to turn out a product, it is inevitable that certain details will have to again be worked upon by the development organization and the troubles remedied. Of course, in developing any new process, it is necessary to carry the laboratory work to a point where both the purity of the product and the yields are sufficiently satisfactory to make a commercial success; and a few hours spent with beakers and test tubes in the laboratory may be the means of saving days in the semi-manufacturing plant, and in a similar way, it is much cheaper to perfect a process in this semi-commercial plant than in the ultimate commercial plant.

SOME PERSONAL REMINISCENCES

"A new organization usually lacks some certain knowledge or experience—either business or technical—which constitutes a weak link in the chain. Again let me illustrate: Just after I was graduated, I made an analysis of a brine for a man in Canton, Ohio, for which I was to receive $100, but after I had sent in that analysis I did not know how to get the $100. If I had known as much about the customary methods of doing business as an ordinary clerk, I would have accompanied the analysis with a bill. When we got our first barrel of potassium bromide, I attempted to sell it. I first went to a school friend in Cleveland who was in the wholesale drug business. He did not use bulk bromides, but he took me to a man just starting in the brokerage business, to whom I stated that the price of potassium bromide was 35c a pound, but we were willing to sell it to him for 25c, and we were about to close a deal, when he said: 'By the way, these bromides are strictly U. S. P., are they?' I said: 'No, they are not strictly U. S. P., but they are equal to the best on the market.' He immediately replied that he could not use them, so I left him and went to an old reliable chemical house in another city.

"Here I explained that our goods were strictly U. S. P. in all respects but one and in that one were fully equal to any brand on the market. They said that they bought their goods from firms of high reputation, and that they did not dare buy from a little one-horse concern in Michigan, that it would affect their reputation if they did. However, they said they had a little business where purity was not so important and they might buy a little if the price was right, and they finally offered me 17c a pound, just one-half the market price. I accepted an order for two barrels and went back to Midland. We opened up the barrels of bromides to see if they looked exactly right. Here and there we found specks, and they were not in as good form as they should be, and we spent most of the next two days picking over the two barrels of potassium bromide crystals to remove every speck or imperfect crystal. We then shipped the two barrels and waited for a remittance. When a letter eventually arrived it stated that they had examined the bromides and found that they were not strictly U. S. P. and asked what concession in price we would be willing to make. That letter sent my heart down into my boots. We needed the money very much. We had closed the deal as we supposed at one-half the market price, what further concession should we now make? Fortunately for the future success of the organization, there happened to be a business man in our office who volunteered to answer the letter. In substance our reply was as follows: 'We are in receipt of your letter of recent date. If the goods are not satisfactory, please return them.'

"I was so scared that the goods would be returned that after signing this letter I was afraid to put it in the postoffice, but finally did, and the next letter from the firm contained a check in full settlement of the account. This letter was another step that shortened the time between the laboratory process and the dividend.

THE VALUE OF RECORDING INSTRUMENTS

"While we had expected to operate the plant night and day, our working capital got down to a point where this was practically impossible, so we cut the fo down to the lowest limit and employed only a watchman at night. It was the duty of this watchman to keep up steam in the boiler and keep two deep well pumps operating so that we would have a full supply of brine to work on the following morning. Watchman's time detectors were not as common then as now, and recording steam gages were only just beginning to be used. We thought that these were unnecessary in our case, because we could tell by the amount of brine pumped during the night whether the watchman had kept the pumps running regularly, but for some unknown and mysterious reason the pumps kept breaking down at night.

"The man whose duty it is was to repair these wells became very suspicious that Henry, the night watchman, was taking a nap occasionally and then in order to make up for lost time, was speeding the pumps up to a point that caused breakages. After these night breakages had occurred several times, I decided to go down to the plant along about the middle of the night and see if the watchman was asleep, but he had a little black and tan dog, and before I got within a hundred feet of the plant, the dog commenced barking furiously, and when I got to the boiler room I found Henry attending to business as usual.

"We were about to let Henry go and get another night watchman, but before doing so we decided to make sure of our suspicion by buying a recording steam gage, and secretly installed it in a closed box in the office. The first morning after it was set in operation we went down with a great deal of interest to see just what had happened during the night, but found that the steam line was very smooth and even and had been maintained at just what we desired. This caused us to believe that Henry did not take a nap every night but did so only occasionally. But when night after night the steam chart continued to report a smoother, evener pressure for the night than it did for the day, we realized that our suspicions were unfounded and that Henry was really an unusually good night watchman. I think the advent of recording instruments marked the turning point in development from small-scale manufacture, where the proprietor had everything under his own eye, to large scale work where organization and automatic equipment is brought into fullest effect. If Mr. Solvay had had some recording pressure gages, it might have reduced materially the 10-yr. interval between the conception of his process and the dividend.

"In the case of the Parsons steam turbine, which was the first in the field, Mr. Charles A. Parsons made a statement before the English Parliament just before his British patent expired—which was 14 years from the date of application—that he had made no money, and asked for an extension or renewal of his patent. After investigation, an extension was granted.

"In all radical inventions, where public prejudice is a factor and a general campaign of education is necessary, it would appear probable that 10 years, more or less, would be consumed in making a new process profitable. While there are a great many statements in regard to the great length of time required to perfect the first indigo process, there are no data that tell when the earlier small plants began to be profitable. It is now more than ten years since the first indigo was made in one of the laboratories of the Dow Chemical Co., but no serious effort was made to commercialize this process until after the war started, and about three years after it was decided to build a commercial plant the process became profitable. However, we had the advantage of much of the previous work done by others, which very much shortened the time required.

"Future development organizations will have the aid of better laboratory equipment, more perfect organization and greater experience, but to offset this, processes in future must be more highly developed in order to meet the prices of competitors who are continuously making their plants more efficient. We therefore leave it to yourselves to judge, but we trust that the few examples given may act as signposts along the way."

Motion Pictures

The program of motion pictures held each evening of the Exposition week in the Coliseum auditorium covered a large variety of chemical and industrial subjects and nothing could have been done by the managers to more fully insure the enjoyment of the visitors than this feature of the program. The profit derived by viewing the many reels exhibited was everywhere favorably commented upon.

Opportunities for Retired Technical Men in the Consular Service

Particularly gratifying results have followed the appointment to consular posts in chemical centers of men who had specialized in chemistry. This is one of the reasons why the consular bureau is looking more and more to the appointment of men with technical education to posts where their training will be of special value to the United States.

Due to the fact that the scale of pay in the consular service is not sufficiently high to be attractive to young men who must rely entirely upon their salaries, hope is being entertained that engineers and other technical men who have retired from active practice of their profession may be induced to take the examination. Service as an American consul abroad carries with it various desirable perquisites which would have compensatory value to many men who are not dependent entirely on their earnings, to say nothing of the very valuable service they would be able to render the industry with which they had been connected.

A consular examination will be held in the late fall or early winter and it is expected that it will be taken by a considerable number of retired technical men. Under the present statutory limitations, no consuls other than those of the first class are appointed except by competitive examination.

Calcium Superphosphate.—Calcium superphosphate made from phosphate which has been ground to pass an 80-mesh sieve, but not finely pulverized, is sifted or otherwise mechanically treated to separate the superphosphate particles, which are larger than the original phosphate particles, from the inert matter and calcium sulphate, which are not larger than the original phosphate particles. (British Patent 122,897—1918. E. A. GAILLARD, 3 rue de Batignolles, Paris. April 2, 1919.)

Observations Made at the Show

The best notes on the Exposition that we have seen are to be found in the advertising pages of our Exposition number. We say this without blushing. There are the illustrations and the facts. In what follows we shall give only random notes made in passing, gossip overheard, and memoranda recorded at various meetings at the Auditorium.

The Hough Nitrator shown last year by the Buffalo Foundry & Machine Co. was displayed in another unit and with slight modification. Aside from nitration it has found a variety of new achievements that are likely to bring it into general use. The main problem in nitration, of course, is the bringing together into contact, as nearly as possible, every particle of each of the substances; in other words, it is a problem of intimate mixing. This Hough apparatus is specially indicated in mixing oils of the type, say, of lubricating oils. To effect a proper blending of these mixtures as now accomplished by bubbling air through them often takes from 24 to 30 hr., while the product is often oxidized and thus darkened in color. This nitrator, it is claimed, completes the mixing in from 1 to 2 hr., does it better, effects a mixture of any desired proportions and in either large or small quantities. In an apparatus ot 2500-gal. capacity the entire contents pass through the whole system twice every minute. The nitrator may also be used in washing a great variety of products at temperatures from those of cooling brines to those of superheated steam.

Another impressive exhibit of the Buffalo Foundry was a 2500-gal. caustic pot made of a special quality of cast iron to withstand the action of the alkali and heat.

A vacuum drum drier was in operation drying sulphite waste liquor and doing it successfully with remarkable speed. The operation is continuous. It is available for tanning extracts, soluble coffee, powdered milk, egg powder and a long list of pharmaceutical food and other chemicals. Still another exhibit was a vertical rapid circulation evaporator for concentrating foaming liquids and materials that demand a minimum exposure to heat.

While visiting at the booth of the Dow Chemical Co. it developed that this company is a large producer of pharmaceutical chemicals. And it is said that the largest use for bromine in the country is for medicines, the natural inference of course being bromo-seltzer. Sales are said to be increasing, which is a surprise, because we were under the impression that the requirement for bromo-seltzer would be retarded by prohibition. This, however, is not the case, from which we gather that near beer, grape juice and even loganberry juice may all be deadly and productive of drunkards' stomachs which were portrayed with such alluring art in red and purple in the days of our youth. The second largest demand for bromine comes from the photographic industry, which also consumes 30 per cent of the silver produced in the country.

Fused magnesium chloride ($MgCl_2.6H_2O$) is made in very large quantities by the Dow establishment. This is used chiefly in the manufacture of magnesium oxychloride cement for interior work, which is of such interest that we plan to publish a separate paper on the subject later.

At the symposium on America's Case in Chemistry Dr. J. Merritt Matthews revised his figures as to the time when we shall have all the vat dyes we need that are made in America. At the Philadelphia meeting of the American Chemical Society Dr. Reese prophesied that we should have them within six months, which Dr. Matthews doubted. In the meantime he has visited a number of works and at the Exposition he predicted that we should have all we need by the end of the current year. That's a little more than three months.

In the exhibit of Roessler & Hasslacher considerable attention is paid to their peroxide products which are used for bleaching. Under the trade name of "Albone" they prepare a 25 per cent by volume solution of H_2O_2 which is shipped in barrels as far as from Perth Amboy to Iowa without deterioration. It stands for months with practically no decomposition. We see a chance for research in the use of peroxides for bleaching in laundries and from the way in which the prices of shirts and collars are soaring we wish they would hurry. Chlorine as a bleaching agent is a grand thing for the shirt and collar makers, but the ultimate consumer is rarely able to appreciate the benefit. The same concern also shows peroxides of the alkaline earths and of other metals. Zinc peroxide is used in surgery and in toilet preparations.

An interesting item in the exhibit of the National Aniline & Chemical Co. is a specimen of moiréed silk ribbon dyed with Dr. William Perkin's original mauve. His discovery of this dye and its tinctorial power marked the beginning of the coal-tar dye industry. Sir William presented it to ex-President W. J. Matheson, in 1906, shortly before his death.

Another unusual feature is a line of certified food colors made in a building erected and equipped for the purpose and in strict accord with the Government requirements. The main exhibit, of course, has to do with the company's large line of colors, including the following vat dyes: alizarine, indigo, carbanthrene olive (from carbazol) and alizarine sapphire, all of which are declared to be available in quantity. Within little more than one year's time this company has added 24 dyes to its list and made them available for commercial use. It is doubtful if any German establishment can show such a record. The company maintains a great research laboratory.

Two new products are shown by the Barrett Co. One is a synthetic resin called Cumar which looks important. It is made by the polymerization of two coal-tar oils which come over at about 172 deg. and 182 deg. C. respectively: cumarone and indene. It has great promise as a varnish gum and owing to its dielectric properties its use is indicated in molded insulation work. It is insoluble in water and alcohol, but readily soluble in turpentine, benzene and other commercial solvents. It serves also as a binder for various molded material. The second, phenanthrene, is available as a substitute for wax in paper and may be taken as the raw material in the synthesis of various morphine derivatives.

The Shawinigan Electro-Metals Co., Ltd., distributed a valuable booklet on the uses and qualities of magnesium. It includes details of foundry practice and a chapter on alloys.

When Dr. Augusti Rossi received the Perkin metal he announced that by the precipitation of a titanium solution by means of an organic acid he obtained the oxide in a state of very fine division. Ground with oil, it showed remarkable covering power as white paint. The exigencies of war prevented its manufacture on a commercial scale, but now, through a corporation called Titanium Pigment Co., Inc., it has been put upon the market under the name of "Titanox." This consists in a mixture of titanic oxide and barium sulphate in proportions of about one to four. Its covering power is decidedly greater than that of either white lead or zinc white. Tests show that it does not crack or check as readily as lead or zinc paints and that in the latter pigments the checking and cracking may be avoided by the use of 50 per cent or more titanox mixed with it. After long exposure titanox paints chalk to a moderate extent, but mixtures of lead or zinc oxide with titanox are more durable than any of the paints alone. An interesting showing is made.

Major Harrison E. Howe of the National Research Council said in talking of its plans at the general meeting in the Auditorium on Thursday, Sept. 25, that there are about 275,000 manufacturing concerns in the United States, of which less than one-fourth of one per cent have laboratories of any kind. Not over one-eighth of one per cent have laboratories worth mentioning and not over 50 in all have research laboratories.

He gave some details of the research organization for alloys which the Council is helping to organize. The plan is to have it more largely composed of manufacturers who need alloys than of those who make them. This is a wise move, and it is in the interest of economy, because it costs a lot more to introduce a new thing, whether it be an alloy or anything else, than it does to make it on specification. And it is also much more likely to bring improvements into use if users know they can be made and need them. It puts the shoe upon its proper foot. One hundred members will be enough to constitute the organization, and these are to contribute $100 each per year for five years. While they will probably require their own central laboratory in time, it is proposed for the present to make use of existing commercial laboratories.

Initial steps are being taken for the formation of other similar associations. In all its work the Council seeks to avoid duplication of effort.

At a general meeting held at the Exposition Auditorium on Sept. 25 Mr. C. Price Green told of the field for industrial development along the lines of the Canadian National Railways. He gave some very interesting statistics, as for instance, that the United States, with 1/15 of the population of the world, uses one-half of the paper made upon it. Just as the writer's bosom was beginning to swell with pride over this he was reminded that all the Hearst papers were published in this country and that there are a considerable number of anarchist papers published not only in English but in foreign languages or that these latter constitute the only literature of any kind that reaches a good part of our foreign population. Then he cooled down. The Chicago *Tribune* uses the wood from 30 acres per day. All the Chicago newspapers use up 5000 spruce trees daily.

Canada produces 90 per cent of the world's nickel, a large proportion of its silver, 85 per cent of its asbestos. It contains the largest known gold mine, and a vast amount of copper. Deposits of sulphide ore have lately been discovered that are so rich that they are profitably hauled 60 miles for shipment by railway.

Graphite is under development by the Timmins people and he predicted that within a year's time there will be offered for sale from this source graphite that is equal if not superior to that imported from Ceylon and Madagascar.

There are marble deposits in Central Ontario that are the oldest on the continent and of unsurpassed beauty. The bodies are of immense magnitude and run for hundreds of feet in depth without a flaw. As the strata lie in a vertical position, the various varieties can be obtained with great economy. Water power is available for the operation, while the product may be run down to the railway by a gravity road.

Only lately manufacturers have begun to realize what potent factors chemists and engineers are. There is great need of technically trained men in that country.

In an address made by Dr. Arturo Liebes of *El Mundo* (a Havana newspaper) he displayed motion pictures of Cuba and her industrial life, he made an earnest appeal along lines that we have touched upon editorially. He protested against the type of representatives sent by American manufacturers to represent them in that country. He said that of 250 such men that he had met, nearly all were outspoken critics of Cuba and Cubans. Many of them made fun of their customers. They had no sympathetic viewpoint with the people. Whatever was done differently from the way current in the United States was wrong, according to these gentlemen. He earnestly hoped that a greater effort would be made to select the right type—which means a more cultured, sympathetic and affable type of export salesman for Cuba.

A clever exhibit made by the Semet-Solvay Co. was a miniature dairy farm covering about 3 sq.yd. Beside each building or field was a label indicating the Semet-Solvay products that are useful. The dwelling house, for example, could use domestic coke, while for the roads calcium chloride was needed to lay the dust. Beside the garage it was recorded that benzene was available for automobile fuel. The chicken house required coal-tar disinfectants and germicides. In the creamery calcium chloride is needed for refrigeration, salt for the stock and for the creamery, while soda is required for cleaning. In the field the use of potash and ammonium fertilizers was indicated.

Another Solvay exhibit was a model in pyrex glass of a cotton-boiling kier designed by Mr. Scott for use in bleacheries to overcome a difficulty from which they suffered. A number of these kiers have been installed and are in successful operation. Their merit consists in the treatment of cotton with caustic in the absence of air, whereby the formation of hydro-cellulose is prevented. After the caustic is drawn off and the wax thus removed the cotton is washed with water and finally bleached in the kier, thus providing for a minimum of handling.

Chicago Meeting Mining and Metallurgical Engineers

Engineers of the Chicago Section entertained the 120th meeting of the American Institute of Mining and Metallurgical Engineers during the week of Sept. 22-26. It was a remarkable meeting in many ways, breaking all records in point of attendance, and in the number of technical papers presented. On Thursday, for instance, between the hours of 10 and 6, about 53 contributions on modern pyrometry and its industrial applications were presented to a largely attended joint meeting of the Institute and the Electrochemical Society. On other days as many as three simultaneous sessions were being held, while the many attractive trips of inspection, the Chemical Exposition, and the meetings held by five other engineering societies made it a difficult matter for the individual to be at the right place at the right time. Unfortunately for the local committee, as well as the visiting metallurgists, the steel strike badly disarranged the excursions planned, since under the circumstances it was impossible to visit any of the extensive steel works in the Chicago district. The usual banquet was held, which was addressed by President **WINCHELL**, and Messrs. **PEABODY**, **ROBINSON** and **SCHWAB**, where the underlying note was one that the engineer would be of enormous economic value in the next few years by promoting the necessary spirit of confidence between worker and employer so necessary for our industrial renaissance. Captain **COUBLVT**, of the French Navy, also spoke, recounting briefly the relation between the present mineral and metallurgical resources of France and their expected needs, together with an outline of the methods by which they expected to bridge the gap.

A very interesting group of about 20 papers on non-ferrous metallography and metallurgy were presented by title only, since they are to be the subject matter of a meeting of the Institute of Metals Division to be held the following week in Philadelphia, held jointly with the American Foundryman's Association, as is customary. These papers will be noted in detail in connection with a later report of this meeting. Pyrometric subjects will not be considered at this time, being reserved for special treatment at length in subsequent issues of CHEMICAL & METALLURGICAL ENGINEERING. A very important series of papers by **FULTON**, **KELLFR MACKAY**, **HANSON** and **HULST** on non-ferrous metallurgy must also, for lack of space, be deferred for later notice at length.

Monday, Sept. 23

Session on Milling

A paper in defence of the Chilean mill was presented by **LUTHER W. LENNOX**, assistant superintendent of the Portland mill, Victor, Colo. He pointed out that this type of grinder has fallen into disrepute of late years, and that in two published tests where they were operated on the same kind of feed alongside ball or tube mill the results were unfavorable to Chileans. However, the feed in these cases was exclusively fine; in other words, the mill was used as a re-grinder, while tests at the Portland mill have demonstrated that a certain amount of relatively coarse material is necessary, upon which the mullers may ride, and which eally act as auxiliary grinding units. Under this condition, with feed which may contain slabs 1 in. thick and 3 in. square, the millers and die are 2 in. apart at their edges and contain 5 in. of mixed sizes closely packed at the middle. With a feed exclusively finer—say, minus ½ in.—the mullers plow their way through the ore instead of rolling over it, and a much thinner bed of material is retained in the grinding zone. Results of a large number of tests are included to support the ideas of the author, while the records show that the mill will reduce the hard, refractory Cripple Creek ores from minus 2½ in. as follows:

	Tonnage 24-Hr.	Size Product	Tons Hp-Day
Open circuit:			
With 6-mesh screens..........	275 to 300	28.5%—200 mesh	2.5
With 18-mesh screens..........	240	32% —200 mesh	2.2
With 30-mesh screens..........	175	35% —200 mesh	1.75
Closed circuit:			
With 6-mesh screens..........	200	42% —200 mesh	1.86
With 18-mesh screens..........	185	47% —200 mesh	1.72
With 30-mesh screens..........	130	52% —200 mesh	1.31

The mills described consist of a battery of six 6-ft. Wellman-Seaver-Morgan Akron Chilean mills, each driven by a 100-hp. motor at 37 r.p.m. Power input is maintained at 110 hp. as near as possible, of which 10.7 represents friction in mill, motor and transmission. In the paper may be found detailed information as to relation of grinding efficiency as it varies with tonnage, dilution of pulp, speed of mill, position of muller, and screen analysis of feed, together with figures of steel and screen consumption.

Mr. C. H. **BENEDICT**, of the Calumet & Hecla Mining Co., observed that they had displaced a 48-unit Chilean installation by ball mills because their service was to grind $\frac{3}{16}$-in. material to very fine sizes. For this work the ball mill is evidently superior, reducing the time lost for repairs from 3 per cent. to less than 1 per cent., while a uniform sized discharge is impossible from a Chilean, owing to progressive screen wear.

Mr. R. B. T. **KILLANI** of the Hardinge Conical Mill Co., pointed out that since the Miami tests referred to by Mr. Lennox were run, considerable advance in ball-mill practice had been registered. Using figures from Mr. Lennox's paper presented at the Colorado meeting on the relative "grindability" of various ores, which have been independently verified, Mr. Killani calculated figures which indicated the probable superiority of the ball mill on equivalent work, figured to mesh-tons per horsepower.

GRAPHIC METALLURGICAL CONTROL

H. M. **MERRY**, metallurgical statistician for the Chino Copper Co., Hurley, N. M., presented a short paper on "Graphic Metallurgical Control," in which he pointed out that the customary method of having several zero points on the same ordinate is likely to produce confusion in interpretation and to militate against its full usefulness. He shows that a logarithmic division of ordinates is more to be preferred, in that the low numerical values, such as "copper in tailing," are properly magnified to their true importance, as compared, for instance, to the figures for "copper in concentrate." An even better ruling is the plain millimeter cross-section rolls wherein the notations roughly follow the mean logarithmic spacings for the region in question, but in this portion the plotting is on an arithmetical scale. The author also describes an ingenious wall cabinet for filing old charts in such a way that they are protected, yet instantly and easily accessible for comparison or study.

Crushing Practice at Ajo, Arizona

Additional information regarding the crushing practice at Ajo, Ariz., was given in a short note by W. L. **Dumoulin**, assistant general superintendent. It was found that when a carload (35 tons) of ore from the shovel pit was dumped into the coarse crusher (No. 24, style K, Gates) set to 9 in. it would pass material so rapidly that the four No. 8 crushers set just below receiving the discharge would be flooded. Concaves and mantles were therefore replaced, so that the larger crusher now breaks to 6 in. and the lower set to 3 in., instead of 4 in. as formerly. This distributes the work more evenly in the coarse crushing plant and takes much work from the secondary Symons disk crushers. A new unit has been installed in the latter department, making 5 in all, with a total capacity of 500 tons per hr., each consisting of one crusher, with a grinding surface 4 in. wide, reducing the ore from 3 in. to ¾ in., followed by two with surfaces 6 in. wide, delivering ¼-in. material (only 18.3 per cent. through 20 mesh!). Repairs on the Symons machines have been reduced by strengthening various details and eliminating more of the tramp iron. Manganese steel used per ton of ore crushed is 0.0113 lb. in the Gates and 0.059 lb. in the Symons.

Tuesday, Sept. 23
Session on Iron and Steel

(Jointly with American Electrochemical Society.)

Raymond M. Howe, of the Mellon Institute, presented a paper on "Blast-Furnace Refractories," in which he collects the results of a questionnaire sent to nine of the leading American furnace plants. Seven of the firms reported satisfaction with both furnace and stove brick, while the failures noted were due to obscure causes which would require detailed study to determine. Thus the refractory industry feels that it has probably met the more and more exacting demands of modern metallurgy with considerable success. The author points out the fact that fire-brick manufacture comprises seven distinct steps, each of which may be adjusted so as to influence quite definitely the quality of the finished product; makers are now giving close attention to all these matters, so that their product will suit the intended purpose as to melting point, density, strength, toughness and uniformity. On the other hand, it is obvious that the purchaser has much to gain in studying and specifying his exact requirements and then insisting that a correct mortar is used and the furnace is built exactly according to the engineer's drawings. When the useful life of the lining is passed, the furnace should again be carefully studied before dismantling starts. Only in this way can progress be effected. Disintegration of blast-furnace linings has been variously ascribed to the effect of carbon, deposited at 300 to 400 deg. C., to removal of iron by gases, and to deposition of alkali. The author points out that if the first two causes are effective, linings could be made more durable by using an iron-free brick or by keeping them constantly above 400 deg., either of which is obviously impossible. On the other hand, there may be great savings made by developing a top-lining with a hard, impervious, refractory glaze.

Effervescing Steel

Two papers on the effect of gas in steel attracted much attention. The first, a clear exposition of the causes and results of "Effervescing Steel," was given by **Henry D. Hibbard**. He notes that the pyrotechnic display of burning steel particles splashed up from the ingot top during and after pouring is due to the evolution of a myriad of gas bubbles, the gas being rendered less and less soluble with decreasing temperature of the liquid. Three zones of blow-holes are caused by such gases entrapped in the mushy steel: First, holes near the surface due to hydrogen. These are relatively rare, because ordinarily but little hydrogen is present and its bubbles are largely washed away by the evolution of the enormous quantities of CO, which is responsible for the deeper-seated holes. Finally, at or near the axis are sometimes found cavities due to residual nitrogen or NH_3. Effervescing steels include most soft steels with less than 0.40 per cent. C, and when properly made (according to the principles laid down in the paper), the ingot will have a flat top with but few holes near the surface due to hydrogen. Even these, if covered by a thick skin of sound metal, so that they are unoxidized, will be welded shut during rolling. The deeper-seated holes are always bright and constitute no defect; in fact, they should be just sufficient in volume to produce a flat-topped ingot, in order that the minimum percentage of billet ends will be cropped.

Determining Gases in Steel

The second paper on this subject was by J. R. **Cain**, of the Bureau of Standards, who outlined the work which is under way toward developing a correct method of determining gases in steel. In a brief review of the previous work he noted that the simplest method in use, i.e., of drilling the metal under mercury and collecting the gases liberated, gives reliable qualitative results and indicates that a part of the total gas content is held imprisoned between crystals. Heating steels in vacuo is difficult and show that various amounts of gas are evolved at various temperatures, indicating, in fact, that fusing the samples will be necessary before quantitative results may be expected. Work along these different lines has disclosed considerable gaseous segregation; that rolling decreases the gas content; that the gases evolved are mainly H_2, CO and N_2; that the solubility increases with temperature and as the square root of the pressure. Detailed investigations have already shown that the Ledebur method of determining oxygen is inaccurate and valueless as an indicator of the physical characteristics of the steel itself, except in the rare case of very pure ingot iron, and that the gas evolved by Goutal's method is generated by carbides in the metal. The Allen method of determining N_2 is more promising, and many improvements in its technique are being made. Possibly it can be developed into the precise quantitative operation which is first needed before serious work can be started to determine the actual mechanism of the degasifying reagents (Mn, Al, Si); the effect of manipulation on gas content, and, finally, how gas content affects the physical properties of the manufactured articles.

In the discussion of this paper, Mr. **CUSHMAN** pointed out that there were probably three separate methods of gas imprisonment; first, atmospheric air in cavities; second, gas in solid solution, and, third, combined in chemical compounds. J. S. **UNGER** pointed out that it is difficult to see how oxygen—which has been reported as being evolved from hot metal—can be present in quantity with such a large excess of iron or carbon. As a matter of fact, it is quite doubtful whether all gas in iron alloys is detrimental: witness the work which has been done on oxygenated cast iron and the growing use of gaseous cementation agents. Mr. **YENSEN** thought that other methods than melting in vacuo were necessary in order to get all gas from metal, since he has made many ingots held molten in vacuo for hours which are full of blow-holes.

THE EFFECT OF TIME ON PHYSICAL PROPERTIES OF MEDIUM-CARBON STEEL

"The Effect of Time on Physical Properties of Medium-Carbon Steel" was described in a paper by G. A. **REINHARDT**, metallurgist, and H. L. **CUTTLER**, assistant of the Youngstown Sheet & Tube Co. In their effort to produce forging steel of about 0.50 carbon and high elongation it was found that test bars which had rested over night gave much better ductility than those tested immediately after machining. Pursuing this matter further, the authors found that improvement by rest was apparently confined to bars cut from ingots, or pieces on which but moderate amount of work had been expended; that rest at 120 deg. C. accelerated the beneficial effect, and that the speed of machining on the test bar seemed to be an immaterial factor.

An animated discussion followed this paper. Many members had used the expedient of aging to get test bars past the specifications, but conflicting opinions were expressed as to whether the forging also improved correspondingly. The interesting ethical point was also raised as to whether it was correct to give a test bar a low temperature anneal—for that is what aging or accelerated aging really amounts to—in order that it may attain a certain physical specification.

AIRCRAFT STEELS

In a paper titled "Aircraft Steels," **ALBERT SAUVEUR**, of Harvard University, points out the confusion during the war which existed because of a multiplicity of aircraft boards, each working independently and constantly issuing revised specifications. No less than 175 different steel specifications had been more or less officially promulgated, when the Inter-Allied Committee on Aviation delegated some of its members to prepare some specifications truly international in character which could be issued to clear the chaos. Dr. Sauveur's paper is largely a reprint of this sub-committee's report, giving condensed specifications for chemical composition, recommended heat treatment and desired physical properties of elevent types of steel, some one of which would appear to be suitable for any particular part of an airplane where steel is desired. Fifteen other steels are included in a second category, in order to satisfy all members of the committee and to cover localized conditions of manufacture.

RIFLE-BARREL STEEL

Rifle-barrel steel was discussed in two papers by Major A. E. **BELLIS** and G. F. **BUTTERWORTH, JR.**, of the Springfield Arsenal. These barrels are made of 0.55 C, 1.15 Mn steel in one of four ways: (*a*) by upsetting blanks, then quenching at 816 deg. C. (Ac = 732) and drawing for 2 hr. at 648; (*b*) by quenching billets from 816 and rolling at 677, (*c*) by rolling at or above Ac; and (*d*) by rolling at 650 to 675. Method *c* gives structure apparently sorbitic at 100 dia., but resolvable into rounded particles of free ferrite in sorbitic ground mass. Method *d* gives typical banded grains, the original structure not being obliterated, merely distorted. Methods *a* and *b* give similar structure of homogenous sorbite, substantially the same for all drawing temperatures, although the degree of heat can be determined microscopically by the tint after standard etching. In manufacture the occasional seamy pieces are almost always exposed, so that few failures result when proof-firing at 40 per cent. excess pressure. Erosion after continued firing is shown by tests to be resisted best by the true sorbitic structure, any network of free ferrite offering easily eroded channels for the scouring action of hot gases and metal.

Evening Session

A description, illustrated by lantern slides and moving pictures, of the huge 240-in. plate mill at Coatesville, Pa., was given by C. L. **HUSTON**. The speaker prefaced his remarks by a brief account of the development of boiler-plate manufacture and the rivalry which lately has existed between mills as to which could produce the largest plates for special purposes. This particular mill is so much larger than its predecessor that it will doubtless be unique for many years. Its construction, of course, involved the perfection of several radically new details in the stands, tables, manipulators and shears, all of which were clearly described.

FUTURE TREND OF MILL PRACTICE

ROBERT W. HUNT read his paper, suggesting the future trend of mill practice to attain a better grade of rails. Some seven years ago he instituted a special inspection, which has since been widely adopted with gratifying results. It consists of placing inspectors in all departments of the steel works at all times, charged with the duty of recording the history of each heat of rail steel. A copy of this is furnished the steel company, as well as the purchaser, so that in the life of any rail should a defect occur, not only a detailed record of its manufacture is available, but personal responsibility may be correctly fixed. Mr. Hunt has also recently recommended a nick-and-break test for each ingot, a practice which is now universally used on Canadian railroads. This merely consists in breaking a piece from the top end of the first rail rolled; if satisfactory, the whole ingot is accepted; otherwise, the bottom end of the first rail is broken, and so on until a fracture free from defect is found. Hot straightening of rails is another step in advance which is perfectly feasible, and which will when generally adopted materially cut the expense in this department, as well as result in improved and safer rails, with a much smoother roadbed. Use of liquid additions will enable more uniform chemical composition from basic open-hearth heats, while a higher average carbon content could be secured if a certain percentage of marked rails with a small excess in carbon would be accepted by the railroads. Furthermore, there really seems no valid reason why all the railroads should not adopt the same chemical specification for their heavy standard rails, which, as a matter of fact, are about the same weight. Hot-top ingots seem not so far distant as a general requirement; milling both ends square, to precise length, is another matter of great importance. Hot milling about ⅛ in. of metal from the outer part of the blooms from which the heads and flanges of the rails are formed has been instituted by one mill, and the process is working to their satisfaction. Perhaps some such expedient will be needed to reduce the growing number of failures due to longitudinal seams and their accompanying crescent-shaped flange breakages, a tendency unchecked by the use of thick flanges.

Wednesday Morning, Sept. 24

Session on Iron and Steel

Impact strength was the subject of a lively discussion precipitated by F. C. **LANGENBERG'S** paper, where he described the results of Charpy tests on some forgings which failed in service and which, upon investigation, revealed low transverse ductility. The author considers that the test is of great value in testing ordnance material, basing his opinion on several years' use at the Watertown Arsenal in both routine and experimental testing. While admitting that notched-bar results are not yet directly correlated to more common physical tests, experience shows that low Charpy resistance or transverse tests indicates brittleness under suddenly applied stresses, a characteristic of the metal not revealed by static tensile properties on longitudinal specimens, even though low ductility transversely could be shown if bars were pulley in that direction. A. C. **PICKENS** gave a brief description of the machine in use at the Naval Gun Factory, which is a vertical drop machine, with graphic recorder drawing a curve of elongation vs. time. Velocity of stretch is given by the tangent to this curve at any instant; acceleration from time to time can then be easily figured, and with the weight of lower head known, a value for stress in pounds per square inch can be figured. This unit for expressing results corresponds to common practice in other tests, and will be an important factor in popularizing the method, especially since an integrating instrument has been designed for interpreting the graphs. On the other hand, Mr. **NELSON** said he had been experimenting with the Izod test for many months with the most erratic results. For instance, a sound carbon bar from stock, when split into sixteenths, would give tests ranging from 15 to 100 ft.-lb. in random sections within 4 in. of each other. Alloy steels, on the other hand, are either consistently good or bad; that is to say, if a certain bar is good "notch-test steel," one cannot get low Izod numbers by even the most careless testing, while a poor "notch-test steel" can have its resistance increased from Izod 4 to 10 up to Izod 40 or 50.

COOLING PROPERTIES OF TECHNICAL QUENCHING LIQUIDS

N. B. **PILLING** and T. D. **LYNCH** of the Research Laboratory, Westinghouse Electric & Manufacturing Co., presented a very valuable paper comparing quantitatively the "Cooling Properties of Technical Quenching Liquids." Using experimental methods developed by Benedicks, the cooling curves of a small cylinder of nickel in liquids at various temperatures were studied, and the derived data summarized in diagrammatic manner. In general, there are three different stages in the quench: (*A*) a layer of vapor is formed between hot metal and cool liquid through which the heat transfer is slow; (*B*) the vapor jacket is condensed, and cool liquid comes in physical contact with hot metal when heat transfer is quite rapid, each bubble of vapor as formed being swept away by convection currents: and (*C*) as the metal cools off, ebullition ceases in the liquid and heat is transferred slowly at temperatures below the boiling point. It is thus seen how the physical properties of steels are quite materially affected by the varying quenching rates common in practice. Quenching oils in general are quite stable; i.e., the curves for a given oil are nearly parallel at all reasonable temperatures, with speed and duration of various stages almost identical. Concentrated sulphuric acid also is stable (in the above sense) and gives high quenching values because Stage *A* (vapor sheath) is entirely absent. Brine is second only to acid in speed of quenching up to about 40 deg. C.; above that temperature Stage *A* appears and becomes of increasing importance. Tap water, on the other hand, is very unstable, always producing a considerable period of slow cooling before Stage *B* sets in, which period lengthens rapidly as the initial temperature of the water approaches its boiling point. A concentrated soap solution at all temperatures quenches slowly because the vapor sheath persists down to metal temperatures approximating 400 deg.

HEAT TREATMENT OF CAST STEEL

An interesting account of the development of a double heat treatment for steel castings was presented by Messrs **HALL**, **NISSEN** and **TAYLOR**, of the Taylor-Wharton Iron & Steel Co. These men demonstrated to their own satisfaction that an anneal of from 2 to 4 hr. at 900 deg. C. was necessary to diffuse the original ferrite in low-carbon cast steel. This soaking must then be followed by relatively quick cooling to prevent the carbon re-segregating at the original grain-boundaries; air cooling was later replaced by oil or water quenching. A second anneal is necessary to remove hardening strains—it must be done below A_1 in order to retain the acquired carbon distribution. One peculiar result of their work was that it was shown that it is necessary to reheat to a lower point after quenching than after air cooling in order to prevent re-segregation of ferrite masses. Experimentation with electric steel of extremely low S and P content showed that practically the same heat treatment is necessary to eliminate ghosts entirely; the authors therefore conclude that good physical properties may be had more cheaply by heat treatment than by insisting on stringent chemical specifications. During the war, good results were had from a 0.25 C, 1.25 Mn steel perfected several years previously for dredge buckets. Intricate gun-carriage castings of this composition were made of basic electric steel, given the double treatment of quenching and annealing without the least trouble from cracking or difficulty in attaining the physical specifications.

American Ceramic Society Meeting

WEDNESDAY, Sept. 24, was set aside as Ceramic Day at the Exposition, and aside from visitation of the many booths devoted to ceramic subjects in the Coliseum and Armory the American Ceramic Society held its annual meeting under the direction of W. D. GATES, acting as chairman, and CULLEN W. PARMALEE, as secretary. The morning session was called at 10:45 o'clock in a conference room in the First Regiment Armory, and papers were presented in order as abstracted below. The Society is to be complimented on the progress being made through the efforts of its many active members in their combined effort to forward the state of the art to its highest standard.

Superior Refractories

In the presentation of this paper, the author, ROSS C. PURDY assumed that the audience had a clear understanding of present conditions in the ceramic art, because so much has already been published in the journal of the society and so much work has already been done by the universities and by individuals on the methods of testing, etc. The paper presented at the Philadelphia meeting of the A. C. S. on the same subject dealt with the need of the industry for superior refractories.

This is a plea to the American Ceramic Society to initiate, directly or through the agency of the National Research Council, active and thorough researches by a Federal Bureau, of our refractory problems. This recommendation is made in spite of a keen appreciation of the excellent work which has already been completed and at present being undertaken by the Federal Bureaus, the National Research Council, the American Ceramic Society, the Refractories Association, the American Society of Testing Materials and other organizations. Much has been done by our universities and much by industrial concerns. In the presentation of this plea there is no forgetting the advances we have made through the efforts of these several agencies and there is no thought but that these several bureaus, societies, universities and industrial concerns should continue independent researches on refractories as has been their wont, and as they no doubt are continuing, for there are advantages in independent investigations by several organizations each with its peculiar purposes, viewpoints, facilities, etc. Indeed we want more of this dispersion of interest and activity in researches on refractories. It would be well if each of the several bureaus, societies, colleges, etc., would see the great need there is for progressive and aggressive investigations of our refractory problems and each independently initiate and prosecute researches in this, the one branch of ceramics in which we are the most backward in meeting the industrial demands for a better product.

ADVANTAGES FROM A FEDERAL BUREAU

Notwithstanding this keen appreciation of the benefits derived from independent investigations and researches by several, we must recognize the advantages of unrestricted facilities, not alone in expensive and varied equipment to meet every desired requirement, but also in facilities for very accurate observations and for obtaining of trustworthy constants such as can be obtained only with highly trained investigators and expensive apparatus. We must appreciate also facilities for broad observations not alone in the development and manufacture of refractories but also the industrial needs for refractories. It is very obvious that the most rapid and the most certain progress in the development of refractories can be had only by an elaborate and aggressive investigation, an investigation that is beyond the possibilities if not beyond the scope of independent organizations of small financial resources and limited interest.

BENEFITS WOULD BE NATIONAL AND WORLD WIDE

Then, too, the benefits would not be alone to the manufacturers of refractories, indeed not as much to them as to the users, and to the national and world-wide welfare. It does not require much breadth of thought to realize how dependent is our present-day industrial progress on the development and manufacture of superior refractories, refractories that are superior for the several purposes than those now being employed. Consider for a moment the saving of time and of labor and of metal that is effected by the closed electric furnace over the open-top crucible for brass melting. The electric furnace today is melting less than 1 per cent of the brass used, and yet it is saving a million dollars' worth of zinc metal by reducing its loss from 6 to 9 per cent down to 1 per cent and less. In this one operation alone electric furnaces are not only saving metal but also labor, and at the same time are making the operation more tolerable for the operators. Examples could be multiplied by reference to the many heat-treating operations where with development of new equipment and processes they are effecting economies and bettering operating conditions. But these benefits cannot be fully realized until more suitable refractories are developed. The rapid development and adoption of electric furnaces for a large number of purposes has given rise to an urgent appeal for better refractories. The development and rate of adoption of the electric furnace has been phenomenal, but is greatly retarded by want of suitable refractories.

ADEQUATE SURVEY BEYOND THE SCOPE OF INDIVIDUAL ORGANIZATIONS

There is an urgent need today for an understanding of the qualities or properties that are wanted in each of the large number of industrial requirements. This is no small task. It involves accurate observations and study of possible variations in operation control in the place and under the conditions that refractories are used. It requires a knowledge of metallurgy and of ceramics and above all it requires an appreciation of the relation of costs to service. The most suitable refractory will at the best be a compromise, not alone because of the antagonistic properties that exist but also because of the economics of service involved. An adequate and worth-while industrial survey and research of refractory requirements is so far beyond the possibility and scope of individual organizations, and the benefits derived are so broad, affecting the cost and pleasure of living of every citizen, that it should be made under the auspices of a Federal Bureau, where the expense is borne by general taxation.

All Citizens Should Share in the Cost

If a discussion of the political economies involved were needed, it could be shown that since our national welfare is more and more dependent on industries as compared to agriculture and since the farm and the industries are today more mutually dependent than at any previous time, all citizens should share in meeting these costs. And if the economy considerations were carried farther, it would be plain that efficiency, relating to time and money expended as balanced against the value of results obtained, would require the employment of the broadest trained investigators, the most accurate and efficient equipment and the most liberal opportunities, all of which are possible only under Federal auspices.

Then, too, there should be extensive research of material resources and manufacturing processes. This should parallel the industrial survey. The two should be closely associated and each be given liberal support. A Federal bureau would secure for this a far better co-operation of the independent organizations than could any other agency, a co-operation that is very essential.

Progress in the Last Two Decades

A great deal of progress has been made in the last two decades, not alone in the refractories themselves, ›ut also in our appreciation of the relative value of the hemical and physical means of judging their suitability. We no longer hear of the mistaken and much over-emphasized importance of chemical analysis of clays. We have not, and probably never will, discarded the chemical analysis as being without value. It has a value, for it does give information, but we certainly have less faith today in the empirical methods of Bischof, Seger and Ludwig for estimating the refractoriness of clay from the chemical analysis. We have learned too, that clays having the same chemical analysis but differing in physical and mineral character may have different values for refractory purposes. Indeed it is not uncommon that a freshly mined clay would have but small value for use in refractories, but will be made an excellent clay by merely weathering. This is an instance of the importance of texture and structural strength, factors that are not disclosed by chemical analysis.

We are appreciating more and more that the success of a clay for refractories is as largely dependent upon its physical properties that make it adaptable for manufacturing processes as it is on its chemical and mineral composition. Indeed, the fact is slowly being appreciated that behavior of a clay in the usual fusion test is dependent on physical properties as well as on its chemical composition. No method yet devised can be substituted for the direct fusion test.

Decided progress has certainly been made in knowledge of the method of study and progress has been made in the knowledge of what is essential in refractories, but we have made but little in the actual production for specific purposes. It is not the purpose here to elaborate upon the relative value of the several methods of studying refractory materials and wares or how to produce desired properties in the finished ware. We are making fair progress in these.

What we need today is the development of refractories that will remain practically constant in their physical and chemical characteristics through the maximum heat treatment to which they will be subjected when in use. We recognize that when a clay is burned in the firebrick kiln the melting together of its mineral constituents is but partly progressed and that further reactions and solution will take place when subjected to more severe heat treatment. We also recognize the importance of such factors as time, oxidation, etc., in the progress of clay fusion. It is well known that clay that appears equal in the fusion test will differ in load-carrying capacities when subjected to heat treatments much less severe than that required to cause them to deform in the fusion test, and we recognize this as one indication that suitability of a clay refractory is not wholly dependent upon its ultimate fusibility, but in fact is more dependent upon its rate of fusion.

From the evidence that is already before us it is apparent that for the most severe heat requirements, the refractory must have had its physical and chemical properties developed to their maximum; far beyond the possibility of alteration in any heat treatment to which they will be subjected in use. If fused bauxite, fused Alumina, sintered magnesia, or silicon carbide would meet all the industrial high-temperature requirements, there would be no need for this plea for Federal research on refractories. There are needs which these materials will not satisfy and for which such as the spinels, sillimanite, zirconia, etc., are better suited. We have heard much of the possibilities of zirconia as a refractory and have had several industrial trials of refractories made of zirconia, but we know little aside from the fact that we cannot yet produce a zirconia refractory that is economically possible. The same is true of sillimanite, a most excellent refractory of exceptionally low electrical conductivity.

The value of these fused refractory oxides lies not alone in their extreme refractoriness, but also in their constancy in volume, capacity to withstand sudden temperature change, resistivity to chemical and slag reactions, ease with which a desired texture can be produced. Refractory articles with these materials average much higher in desired or required properties than any of the partly fused or partly sintered refractories. No refractory will carry load at high temperatures and withstand the destructive abrasive slagging and temperature changes as will fused bauxite, silicon carbide, sintered magnesia. These same superior values may be found with other materials which have been previously fused. The great problem with them, however, is their production on a cost basis compatible with the service they will give. The solution of this problem is not easy and certainly deserves the serious attention of a Federal bureau, with its extensive capacity to conduct investigations in the laboratory and field.

Plea for Co-operation by Other Societies

The plea that is being presented is that the American Ceramic Society initiate and secure co-operation by the several other societies in a request for aggressive researches by some Federal bureau in the development and economic promotion of refractories. This will include a definition of the possibilities of clay refractories; an improvement in such as the silica and magnesite refractories, but especially should such a research develop and define the most economic method of production and use of such a superior refractory as can be made of zirconia, the spinels, sillimanite, the nitrides, etc. This is no small program. It will tax even a Federal bureau if executed with the vigor that the present urgent industrial demands fully warrant..

This plea is respectfully submitted to the Standing Committee on Research for their careful consideration.

Discussion

Mr. PARKER.—It is known that the Government made inquiries regarding certain clays during the war. The Government should be interested in the establishment of a bureau. Considerable work has been done in Pittsburgh. The execution of Mr. Purdy's ideas would make for great strides in the progress of the art,

Mr. HOWE.—Co-operation is a good iead in this connection. The Manufacturers' Association has found considerable saving would be effected.

Mr. W. D. GATES.—This paper is opportune. I hope this collective effort will be made, as it will cause ceramics to become an art indeed. Interchange of experiences has done more than any other thing for the day-working industry.

Mr. CULENDAR.—Mr. Purdy has made a very valuable suggestion, and if he will furnish us with a copy of his paper we will see that it is published in the journals of the Brick and Tile Manufacturers' Association and the Society of Testing Materials. It is to be hoped this paper will bear fruit.

Mr. SILVERMAN. — The manufacture of lapidolite would be benefited by the research work of such a bureau. When substituted for feldspar it eats through the pot ring in two or three days. There is need for such research in the manufacture of white glass as covered by Mr. Pratt's paper read before the American Institute of Mining and Metallurgical Engineers. The Ceramic Society is indebted to Mr. Purdy for his paper.

Mr. C. W. PARMALEE.—This paper is very interesting and the co-operation desirable. The National Research Council already has such a plan on foot. We should therefore co-operate with it rather than deal direct with the Government. The plan should be put through, but the method is in question. The work might be handled by another agency than by a government bureau. Ceramics is a key industry and the co-operative effort of the American Ceramic Society is a good example to the other institutes and societies.

ANOTHER MEMBER.—We should act immediately while other societies are in session in Chicago, and I move we request our Standing Committee to at once notify the Research Committee of the American Institute of Mining and Metallurgical Engineers of our activity in this direction. Motion was seconded and carried.

Mr. ROSS C. PURDY.—I have tried to express appreciation for the co-operative work already done, but for many purposes the clay refactory will not serve. As regards silicon carbide, slabs 10 in. long by ⅜ in. thick have stood tests perfectly. Alundum has stood 50 lb. per sq.in. at 1400 deg. C. with knife edges used as supports for test piece. Two materials will not meet all tests required, however.

Mr. LINDBERGER.—Tests of fused bauxide and silicon carbide bear out Mr. Purdy's statements. They are not sufficient for all purposes, however. No. 1 fire clay softens below fusion point and ruins the structure. I suggest the use of superior refractories at vital points in the structure rather than in the entire body in order to strengthen and economize in cost of the work.

The laboratory is a hard place to determine all the requirements. The work should be handled by some bureau and on a commercial scale. Users of brick should be in close co-operation during progress of the investigations. Laboratory tests are good, but a bureau could make severe service tests to meet every condition.

Mr. SILVERMAN.—I suggest we include co-operation in the movement with all the societies.

The motion made previously was so amended.

The Past, Present and Future of the American Ceramic Society

This paper, by Prof. CHARLES F. BINNS, was very interesting. In part he said:

The American Ceramic Society was founded in 1899, at Columbus, Ohio, when a small group of scientific men, interested in the problem of silicate industries, gathered together and formed a permanent organization. Beginning with the report of that meeting a volume of Translations has been published each year for nineteen years. In addition to the annual volume, a Manual of Ceramic Calculations, as an appendix to vol. 11, and the works of Hermann A. Segar, translated from the German, were published.

The subjects which first claimed the attention of the Society were those concerned with the clay-working industries, the properties of clay, the various types of glaze, and the control of kilns. Befofre long, however, portland cement came in for a share of notice, to be speedily followed by sand-lime brick, glass and enamels for steel and iron. The necessary properties of paving brick were closely investigated, as was also the resistance of porcelain to electric tension. A glance through the early volumes of the transactions cannot fail to reveal the broad scope of the activities of the members and the earnestness of their application.

YOUNG MEN INTRODUCE NEW METHODS

At the opening decade the influence of the younger men began to make itself felt. Of the earlier group none had received training in a college of ceramic engineering. Facilities for such training did not exist. Some of the men had studied abroad, and all had graduated from the school of experience. The new men introduced new methods and contributed valuable enthusiasm. The use of engineering expressions became common and greater accuracy in investigations was manifest. The membership did not increase rapidly nor was the balance held by the treasurer an overwhelming burden. The policy of the Society was conservative. The motto was quality rather than quantity. This was sound practice, because the influence of the schools could not be expected to spread very rapidly and without a thoroughly trained personnel the industries could not greatly improve their methods.

NATIONAL GOVERNMENT INTERESTED

A notable step was taken by the National Government in the year 1909 when, stimulated by the demand for improved processes and fostered by the interest of the members of the Society, a department of ceramic research and development was founded in connection with the Bureau of Standards. Laboratories were opened at Pittsburgh and Prof. A. V. Bleininger was placed in charge.

GROWTH SINCE 1912

Up to 1912 there had been but one Local Section organized, the Beaver, later changed to the Pittsburgh District Section. At the annual meeting of 1918, charters were granted to six more, namely, the New York State, Northern Ohio, Central Ohio, St. Louis, New England and Chicago, while the Eastern Section was chartered in 1919. These sections hold meetings three or four times a year and are sources of membership, enthusiasm and general society backing. The four ceramic schools, Ohio State, Illinois, New York and Iowa, have student branches which are usually stepping stones toward membership in the parent society.

The growth in membership was steady but not large until about 1917, when conservatism yielded before a vigorous campaign under the Membership Committee, resulting in an increase of over 200, a movement which has continued up to the present, when there are 1156 members. In 1918 the annual volume of Transactions was superseded by the *Journal of the American Ceramic Society*, with G. H. Brown as editor. There has been a gratifying improvement in this journal during the year and three-quarters of its existence, and it now ranks with the scientific journals of much larger societies.

FORMATION OF DIVISIONS NECESSARY

As a natural result of large accessions of membership there came the formation of divisions. With a body so large it was obvious that every interest could not be adequately represented upon a general program. It was also obvious that special technical questions could best be discussed by small groups of men who were immediately and closely interested in them. The formation of divisions made possible the solution of the problem. There are at present the glass, terra cotta, enamels, refractories, brick and tile, white ware and porcelain, and wall and floor tile divisions. Their organization is being perfected and several have already made notable progress. It is expected that at annual meetings hereafter there will be one or two general sessions, with the remainder of the time given over to divisional meetings.

FUTURE HOLDS PROMISE

The future holds much promise for the Society and for the industry it represents. Conservation of fuel will be studied, labor problems met, electrical energy utilized to the utmost, and the ceramist will seize the materials provided by the bountiful earth and will make them his servants.

DR. TRAVERS, of Great Britain.—The Empire encourages co-operative research of the manufactures, and for this purpose there is a fund of about $20,000,000 available. There is a non-profit co-operative company formed with the various concerns as members. A company appropriates a sum for certain research work and the government puts up an amount from one to five times as great depending on the nature of the work at hand. The company submits only a balance sheet to the government covering the expenditures, and is not otherwise interfered with. When the project becomes self-supporting the government withdraws its support.

Some Aspects of Scientific Research in Relation to the Glass Industry

Speaking on this subject, Dr. **EDWARD W. WASHBURN** said in part: Although one of the most ancient of the chemical industries, the manufacture of glass, like most of the other ceramic industries, has been one of the last to feel the influence of modern science. This is of course due largely to the fact that the industry, being older than the science, had necessarily to develop along purely empirical lines. The rule-of-thumb methods, and their accompanying "trade secrets," which characterize the development of a complex industry by this method naturally bred a conservatism of viewpoint which did not easily appreciate the value of scientific research or the advantages of scientific control over the materials and the processes of the industry. Furthermore, it must be admitted that until comparatively recent times the chemistry and physics of high temperatures, such as those prevailing in the most important processes of this industry, were so little developed that the science was scarcely itself in a position to render important service to the industry, such a service, for example, as organic chemistry has rendered to the synthetic dye industry, which is a typical example of a great industry built upon a highly developed scientific foundation and completely under the control of scientific methods and the results of continuous research.

KNOWLEDGE AND ITS APPLICATION INCREASING

With the development of methods of producing controlling and measuring high temperatures in the laboratory our knowledge of the chemistry and physics of high-temperature processes has steadily increased and applications of that knowledge have naturally followed. The stimulus of the war has aided greatly in bringing together the practical man of the factory and the scientist of the laboratory. But in glass making we know *how* today much better than we know *why*. Progress demands that we know why. No industry which merely knows *how* is in a healthy condition. The feeling of confidence which comes with knowing the why of every step in the manufacturing process carries with it certainty of control, progressive lowering of costs, enhanced protection of the workmen, progress in the development of new and improved products and a degree of insurance against such evils as might otherwise attend the exhaustion or temporary scarcity of certain raw materials, fuels, machinery or other necessary supplies.

In the face of the imperative demands of war, or of the almost unlimited markets created by the destruction wrought by war, the necessity of operating with the greatest efficiency is not felt by an industry as it is in normal times with close competition and a market whose further expansion is dependent primarily upon lower selling prices. This is well illustrated in the case of the first two glass factories to resume production after the evacuation of Belgium by the Germans. These two factories, which I had the opportunity to visit this summer, are located in the same district and therefore subject to the same conditions regarding fuel, common labor and costs of materials. They are both engaged in the manufacture of window glass, for which for some time to come there will be an enormous demand for reconstruction in the devastated regions. In the first factory the glass is manufactured by the older process in which the "metal" is gathered directly from the furnace on the end of the blower's pipe and then blown into a long cylinder which is cut lengthwise, transferred to the flattening furnace and there flattened into a sheet by a second workman. In this factory the blowers are paid from $250 to $300 per month. In the second factory operating under the Foucoult patents, the process is entirely mechanical, no labor other than that involved in the firing being employed between the point at which the "batch" is shoveled into the tank furnace and the point at which the completed pane of glass issues from the furnace. The highest paid workman in this plant received about 18 cents per hour. In spite of the apparently great difference in efficiency and in costs of the two methods of operation they are nevertheless both able to operate at a profit in a market where demand and not manufacturing costs is the principal element in determining the price of the product.

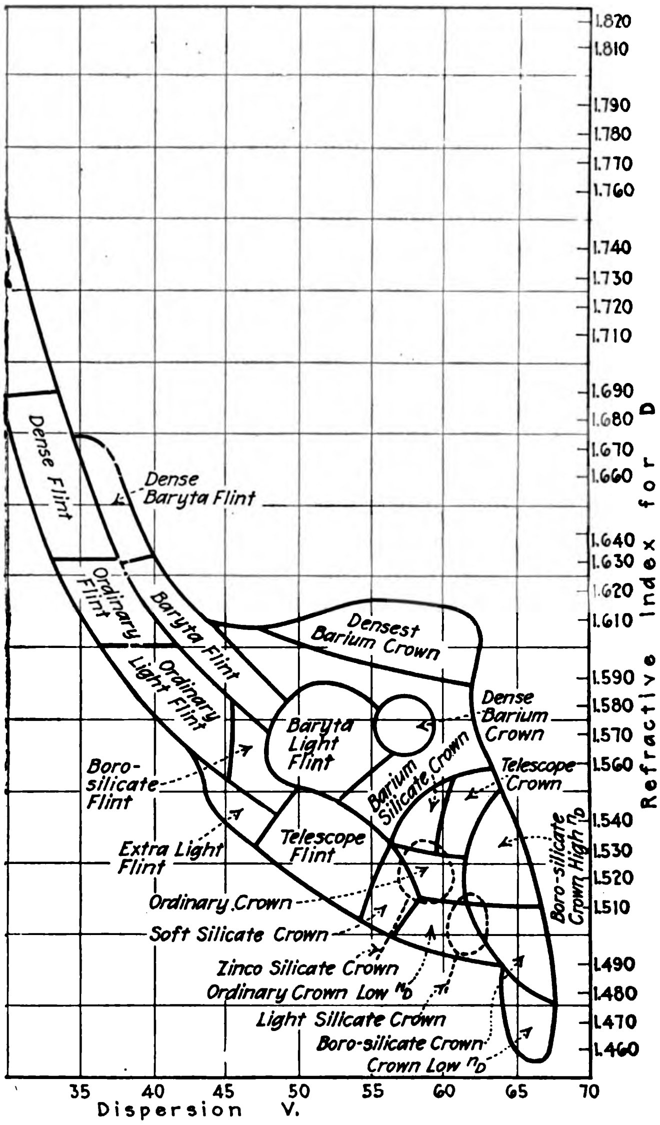
WORK TO BE DONE IN INDUSTRIAL LABORATORIES

In industrial laboratories the work to be done may be roughly classified under three headings: (1) routine testing of raw materials and products and similar control work; (2) works problems, including the curing of troubles and the improvement of processes and products; (3) fundamental research to find out the *why* of the operations or to secure quantitative scientific data covering materials, processes and products. In the glass industry almost all of the fundamental research work remains to be done. For example, very little is known of the relations between (1) viscosity and (2) temperature and composition, although viscosity has long been recognized as of great importance in making and working glass. Surface tension and vapor pressure and even density have scarcely been studied at all.

Of the reactions and compounds we know almost nothing. The nature of gases remaining in solution is almost unknown, as well as their effect, if any, on the properties of the glass. Many unanswered questions are referred to, including relations between composition and properties, cause of greenish color resulting from substituting soda for potash, the condition of copper in glass, the cause of pink color from manganese, and red in chrome pink, the function of arsenic. These are only a few of the questions recently brought to my attention by an authority on colloid chemistry.

HOW RESEARCH MAY BE PROSECUTED

There is thus no lack of chemical and physical problems in connection with the glass industry whose solution requires only the painstaking work of trained investigators. It is not enough, however, merely to point out the great need of fundamental research in this field; it is necessary that definite steps be taken to prosecute this research as vigorously as possible. Now, there are three types of laboratories in which research of this nature might be carried out. First, the research laboratories of the industry itself. These laboratories, while as yet few in number, may be expected to grow in number, equipment and personnel, and a portion of their resources should be devoted to some of the more fundamental problems common to the industry as a whole, as a part of their contribution to the general advancement of those branches of the physics and chemistry underlying the industry. Secondly, the government laboratories and the laboratories of research foundations, such as the Geophysical Laboratory. These may be expected to continue their work along these lines and should receive the support of the industry in their efforts to extend their facilities for such work. Thirdly, the laboratories of the ceramic departments of the universities. Now although we have some half dozen departments of ceramics in the country at the present time, these departments have grown up around and been fostered by the clay industries and have as a natural result confined most of their activities in the past to these branches of ceramics. There exists nowhere in the United States a single professorship of glass technology. I believe that no one of the institutions at which a department of ceramics exists is financially able at the present time to expand its activities.



SCIENTIFIC LEADERSHIP PASSING FROM UNIVERSITIES TO INDUSTRIAL RESEARCH LABORATORIES

In the past the industrial world was content to rely entirely upon the universities for the advancement of science, but today there are many signs that scientific leadership is passing from the hands of the universities to the hands of the great industrial research laboratories and the privately endowed research foundations. Scientific research is becoming more and more costly and the universities as organized at present can no longer compete on terms of equality with the efficiently organized and adequately financed industrial and endowed research laboratories.

Thus, although no longer entirely dependent upon the universities for scientific research, the industrial world is and must continue to be entirely dependent upon them for the training of its technical personnel, and a part of the responsibility for seeing that such training is provided must in the future be accepted by the industries. Although the Sherman law forbids the formation of combinations in restraint of trade, there is, I believe, nothing in that act which forbids the formation of combinations within an industry for the purpose of uniting on a program for furthering research on fundamental problems and for aiding the universities of the country in the work of training the technical personnel required by the industry.

The afternoon sesssion was opened at 2.45 p.m. at the New Southern Hotel. Lantern and other arrangements were provided by the local section.

Twenty-three Types of Optical Glass

Robert J. Montgomery, the author of this paper, said it was the first article within his knowledge that contained a general survey of the subject of optical glass as regards its technical classification. He continued:

By the word optical we mean those glasses which are selected for certain purposes because of their behavior toward transmitted light. This behavior is primarily due to the composition of the glass and not to its shape. Practically all of these glasses are silicates. There are a few special glasses containing no silica, as borates and phosphates, but they are of minor importance as far as quantity of glass manufactured is concerned. Each constituent has an effect on the index of refraction and the dispersion of the glass, and these two properties identify the glass as being of a certain type. Glasses not called optical glass are those made to meet some other requirement than that of index of refraction and dispersion. These will include ordinary soda-lime and lead glasses, in which the composition may be changed to obtain satisfactory melting qualities or in thermometer glass, where the coefficient of expansion is important. The main difficulty in making optical glass is in obtaining the required optical properties and at the same time so combining the constituents and handling the material that a good quality of glass will result.

A study of published information combined with our practical experience in the manufacture of optical glass brings out that: (1) All the glasses may be plotted on co-ordinate paper, allowing the dispersion to be represented by the horizontal distance and the index by the vertical distance; (2) that the glasses fall into natural groups in the field plotted and may be divided into types according to composition; (3) that there are 23 ordinary types of optical glass, each type embracing a number of glasses quite similar in optical properties, composition and method of manufacture; (4) that the composition of the glasses may be divided into two divisions: (*a*) Basic oxides affecting the optical properties, and (*b*) control chemicals which affect the melting behavior. The basic oxides are SiO_2, K_2O, Na_2O, CaO, BaO, PbO, ZnO, B_2O_3, etc., while by the control chemicals are meant the proportioning of carbonates, nitrates, chlorides and sulphates or the use of As_2O_3 and Sb_2O_3 to obtain good melting conditions.

The illustration shows the fields occupied by the various types of glass with an index 1.45 to 1.800 and dispersion value from 20.0 to 70.0. These are listed in Table I. The ones marked with a star are now being successfully made in commercial quantity in this country.

TABLE I.

1 Boro silicate crown
2 *Boro silicate crown, high N_d
3 Crown of low N_d
4 Light silicate crown
5 *Ordinary crown
6 Telescope crown
7 *Ordinary crown of low N_d
8 Soft silicate crown
9 Zinco silicate crown
10 Barium silicate crown
11 *Dense barium crown
12 *Densest barium crown
13 *Baryta light flint
14 *Baryta flint
15 Dense baryta flint
16 *Telescope flint
17 Extra light flint
18 Boro silicate flint
19 *Ordinary light flint
20 *Ordinary flint
21 *Dense flint
22 *Extra dense flint
23 Densest silica flint

It will be noticed that we have now made in this country 12 out of the 23 ordinary types of optical glass. Most of those which have not yet been made have not been attempted because of lack of demand for the glass.

In making this survey of optical glasses only the general compositions are discussed. There is a natural field in which we normally use each constituent. This does not mean that such constituents may not be used outside of its natural field to control the optical properties or the quality of melting. The amount used in such cases is small and does not affect to any considerable extent the type of the glass. When it is desired to develop a new glass with new optical properties its composition can be roughly determined by interpolation between known points in the fields, and the necessary chemicals are definitely shown except in those cases where unusual materials are used. Special glasses not containing silica, as borates and phosphates, are not considered in this paper, and a few special ones within the field given are left out, as they do not bear directly upon the general subject.

Discussion

Dr. **Hostetter**.—Mr. Montgomery is quite right in stating that the band on the left of the chart should really be a line. We made a similar diagram some time ago and thought it would be absurd to give names to various types of glass, so attempted to describe each by its index number. Lens makers, however, are interested in *partial* dispersions, therefore the numerical symbol could not be used. We finally gave up, but decided something more definite in classification should be evolved.

Mr. **Montgomery**.—I agree this classification is indefinite and a new one should be based on partial dispersion. The names we have given, however, are generally used and this chart, being only for *general* classification, is the best we have at present.

Dr. **Turner**, secretary of the British Society, is called upon and while having nothing to say on the paper brings hearty greetings of his society. Appreciates welcome he has received in the United States and the work that is being done between the two societies. Wants to make arrangements for the joint meeting next year. Feeling the need for information on ceramics, the British Society has projected the publication of a series of pamphlets for the benefit of the industry.

Other Papers

Brick and Tile, **Douglas F. Stevens**.—I have been requested to speak as a representative of the Brick and Tile Division. This has been most recently organized because if not done the work would have been buried by other activities of the Society. The Ceramic Society has done much and can do more for the brick and tile industry.

Directed toward chemical uses, it was originally used only for chemical stoneware, but we find now that the chemical plant puts it to all sorts of uses. More has been done in this connection than ever before during the last year. When the speaker visited the government plants at Sheffield, Ala., and saw the extensive use of ceramic ware and brick in the acid and ammonium nitrate plants he was glad to be in business. Here the most beautiful specimens of brick and tile work that he had ever seen in the construction of coolers, acid towers, tank linings, floors, flues and innumerable other places where proof against deterioration from acid and alkali solutions was necessary, were in evidence. This sort of work has been going on for four or five years and it is up to research parties to find new uses for brick and tile.

The value of fuel is steadily increasing. The ceramic industry consumes fuel in the greatest quantities of any except the steel industry. Much work needs to be done on more efficient use of fuels. The effects of alkalies and lime in driers and kilns must also be studied.

The brick and tile manufacturers are coming to appreciate the efforts of our society and we should secure more of them for membership. They are alive to its benefits, appreciate the work the universities are doing and will co-operate heartily with us in the activities of the future.

Artificial Silimanite, A. MALINOVZKY.—This paper contained a lengthy technical discussion of the method evolved by the author for producing artificial sillimanite, complete with chemical reactions, numerous lantern slides and a thorough explanation of the method of operation of the furnace. Analyses of resulting products showed progress of the reactions and microscopic views exhibited the lnong needle-like crystalline forms of the physical structure.

The Making of Pottery, FREDERICK H. RHEAD.—The most commonly known ceramic decorative processes are divided into ten broad groups. Each group is briefly reviewed with particular reference to typical examples ranging from the primitive or early works to modern productions. The processes of primitive, medieval and modern potters are discussed from a practical point of view. A description of various methods, tools and the physical condition of the materials is given, while the artistic and commercial developments are suggested by illustrations of examples referred to in the paper.

The groups enumerated are as follows:

First, incised and etched surface decorations, examples referred to: Early British, Chinese, Italian Sgraffito, Modern Porcelain, Cast Sgraffito, and commercial tile treatments.

Second, modeled and relief surface decorations. Examples referred to: Ancient Chinese, Roman, Eler's style, Palissy, German Stoneware, Wedgwood, Modern.

Third, slip processes. Examples referred to: Old English, Toft, European, Modern Slip Decorations, Pate-sur-pate.

Fourth, underglaze processes. Examples referred to: Grecian, Italian, Majolica, Chinese, Japanese, Modern European, commercial processes.

Fifth, glaze manipulation. Examples referred to: Chinese, Persian, European, Modern.

Sixth, plain glaze treatments. Examples referred to: Chinese, Modern.

Seventh, lustre processes. Examples referred to: Persian, Spanish, Modern.

Eighth, overglaze decorations. Examples referred to: Chinese, European, Modern.

Ninth, sculpture. Examples referred to: Chinese, Italian, European, Modern.

Tenth, architectural pottery. Examples referred to: Babylonian Bricks, Della Robbia, Mexican, European, American, Italian Mosaic.

Buy on Analysis, DR. ALEXANDER SILVERMAN.—This paper deals with the variations in composition of soda ash, pearl ash, limestone, quick lime, burnt lime, sand, litharge, niter, salt cake, zinc oxide, alumina, china clay, feldspar, fluerspar, cryolite and other minerals and chemicals used in the manufacture of glass. It illustrates the wide range of possibilities in composition and emphasizes the necessity for purchasing one kind of material for a given manufacturing purpose. The author points out that there is not so much danger in the difference of composition as in substituting a material of one composition for that of another formerly employed in glass making at a given factory without making necessary corrections. The paper further emphasizes the importance of the density of material such as soda ash and the mechanical analysis of sand calling attention to variations in grain size which might produce different results in glass manufacture.

The Manufacture of Optical Glass, DR. J. C. HOSTETTER.—In 1885-90 George Macbeth successfully started the manufacture of optical glass in the United States, but the industry was not really developed until the advent of Bausch & Lomb in 1912 and the Pittsburg Glass Co. and Spenser Lens Co. in 1914. With this somewhat restricted production as a basis, the industry received a tremendous impetus due to the requirements for a large tonnage in military uses.

It was necessary to produce large quantities of containers for melting the glass, and the Bureau of Standards and U. S. Geological Survey aided in obtaining the special clay needed. These crucibles are slowly constructed by hand and heated for seven days at a temperature of 1000 deg. C. They are then placed into the furnace for filling. The Armour Fertilizer Co. furnished a fine grade of potash containing only from ½ of 1 per cent chloride down to 0.0002-0.0003 per cent. The pots are used for one melt only. The heat is regulated through optical pyrometer readings.

Homogeneity is the main requirement in the manufacture, and the mass is constantly stirred by clay tubes both hand- and machine-operated. The stirring continues during the heat and at intervals while cooling. The mass is finally cooled and broken into large pieces, of which only the best are selected. The first rejection consists of about 80 per cent of the total, and 50 per cent of that is rejected on the second inspection. After many subsequent inspections the finest product is pressed into final form and shipped.

The United States probably doubled the production of the Jena output during the war period, starting from a negligible production at the outbreak

The Menace of the Postal-Zone Law

By Frank W. Mondell

Representative in Congress for Montana

I AM opposed to the zone system for the dissemination of news, ideas and information because I am of the opinion that the establishment and maintenance of such a policy would, in the long run, have a most unfortunate, harmful and regrettable effect upon the American people.

If we are to maintain peace, order and justice under the institutions of free government within our borders, we must have a homogeneous people guided by the same principles and inspired by the same ideals. This condition essential to the maintenance of free government can only be secured by the widest possible circulation of those instruments and instrumentalities which inform, mold and affect public opinion.

Any policy which tends to make us provincial or parochial as a people, which tends to build up zones of influence and information, is a policy not only harmful but one that long continued and widely extended would prove fatal to free institutions. On the other hand, a policy which makes equally available to the people in all parts of the country the journals and magazines which convey information, carry current argument, analysis and entertainment, tends to maintain those conditions essential to our institutions.

Those whose views or arguments for the zone system are based primarily or largely on its effect, or alleged effect, on postal revenues, or the profits of the publishing business, fail utterly to grasp or realize the larger and infinitely more important aspects of postal systems as they effect the national life. If it be a fact that the flat postal rate on newspapers and magazines has been unduly low, that is a matter for consideration by the Post Office Committee, having in view the traditional policy of the American people. The fact that some people have been able to make a considerable amount of money in the newspaper and magazine business is, of course, one of the matters that a committee would consider in this connection, but it is by no means conclusive that a policy is wrong because some people have been able to make money under it—many having the same opportunities and privileges failed utterly.

The demand for the establishment and maintenance of a zone system is particularly lame and illogical when it is made by those who are urging a flat rate of one cent on letters. Such people to be logical should insist upon a zone rate for letters as well as papers and periodicals. Neither is the argument for a zone system strengthened by exaggerated statements of losses to the postal revenues under a flat rate. Undoubtedly the former flat rate did not wholly reimburse the postal revenues, but the most superficial examination of the matter renders ridiculous exaggerated statements of alleged losses. To the argument that publications enjoying the second-class rates are devoted more or less to advertisement, I offer the suggestion that a national dissemination of attractive advertisements is not without its educational benefits.

I have neither urged nor considered this as a party question. I urged this repeal before the previous Democratic Congress, as I shall before the present Republican Congress—not on party or partisan grounds, but on the broad platform that such a policy tends to circumscribe and provincialize our national life to our great haven as a people.

Preparation of Fuller's Earth

By W. C. Phalen.

The bleaching action of fuller's earth is independent of its chemical composition, but depends entirely upon its selective power of absorption or capillary action. Therefore the slight variations in the analyses of the earth bear no relation to its bleaching powers. As is well known, the main use of fuller's earth is for the bleaching of petroleum oils, and the gravity method is used in preference to agitation. The main object sought is to get the lightest possible color with the most prolonged use of the earth, the renewal of which is accomplished by burning.

In a recent article by C. R. Siegfried (*National Petroleum News*, Aug. 20, 1919, p. 38) it is pointed out that the blame for poor filtering is often placed on the earth, whereas it is due to improper manipulation. It is important to bear the following factors in mind: (1) The longer the column of earth, the better the bleach and the lighter the color of the oil, other conditions being equal. (2) The coarser the earth, the more rapid the flow and the poorer the bleach, other conditions being equal. (3) The higher the temperature, the faster the flow and the poorer the bleach, other conditions being equal. (4) As a corollary, filtration should take place at the lowest temperature at which the oil works well. (5) The oil which is being filtered must be fluid enough to be acted on mechanically by the internal structure or pores of the earth, for it is in these pores that the coloring ingredients of the oil are retained, and not in the spaces between the grains themselves. Each particle of the earth, therefore, has its own work to do independent of the others.

The preparation of the earth prior to its going to the filtration plant is of great importance. It follows that the workman firing a burner for fuller's earth is the party who breaks or makes the life of the earth in the filter. The preparation is done by burning and the first burning is the most important of all.

All fuller's earth is hygroscopic, that is, it absorbs moisture from the air. During the first burning it is essential to get rid of this absorbed moisture and also the chemically combined water. The quantity of water varies from 10 to 15 per cent, and this must be expelled before the earth goes to the filter. Organic and volatile salts are also expelled during the first burning, and calcium carbonate is converted to caustic lime.

It has been found by experiment that the best temperature for the initial burn is 600 to 700 deg. F. At this temperature all moisture is expelled and there is no danger of fusion or incipient fusion, whereby the particles are glazed, the pores closed and the absorptive power lost.

The second burning is almost as important as the first, as there is a greater tendency for the grains to fuse and stick together than in any subsequent burnings. It is, therefore, run more slowly than the first or subsequent burnings, and at a temperature of 1050 to 1100 deg. F. In subsequent burns with Florida earth, the proper temperature has been found to vary from 1100 to 1200 deg. F. Any temperature above 1200 deg. causes a loss of filtering power. It was found on the fourth burning of two samples of earth from the same filter that of two samples—the one burned at 1100 deg. F. and the other at 1400 deg. F.—the overburn of 300 deg. F. caused a loss of filtering power of 30 per cent.

Synopsis of Recent Chemical and Metallurgical Literature

Some World-Wide Problems of the Chemical Industries.—Dr. H. GROSSMANN gives in the Dec. 4, 1918, issue of *Technische Rundschau* a review of some of the world-wide problems of the chemical industry. He states:

The obtaining of sufficient quantities of food is intimately dependent on the manufacture of great quantities of artificial fertilizers. This can be attained only by working with all available forces on the problem of supplying European and American farmers with potash salts, phosphates, and nitrogenous fertilizers. The large and productive potash deposits of north Germany assure the Germans of a sufficient supply of these for the present and the future. These must be regarded as the cheapest of all artificial fertilizers.

Still greater achievements have been made during the war in the production of nitrogenous fertilizers. It is now generally known that without the great successes of present science and technology in the manufacture of artificial saltpeter, synthetic ammonia and calcium cyanamide, the great war would have been lost by Germany within a few months of its beginning. England, France and recently even the United States took up energetically the same questions, in all cases the governments actively supporting these industries. In the next few years we can even count on an oversupply of these nitrogenous fertilizers, as a result of this great activity during the war.

The manufacture of calcium cyanamide in such large quantities gave rise to a greatly increased production of calcium carbide and it is in place to consider whether this latter fact may not lead to the manufacture from it of alcohol and acetic acid cheaply and in large quantities. Such industries may attain great importance in countries having large cheap water powers, such as Switzerland and Scandinavia.

Another important world problem is the more rational and efficient utilization of our fuels. We must particularly produce liquid hydrocarbons, which will replace petroleum and its derivatives, such as benzine, motor oils, lubricating oils and paraffine. On the basis of what was accomplished in Germany during the war in the way of using bituminous and brown coals so as to obtain from them products similar to those mentioned, we may predict that further advances in this direction are sure to be made. Even as it stands at present, Germany is assured a greatly increased supply of benzol from these domestic fuel plants, while great quantities of tar and tar oils, fuel oils and motor oils are also made by the same processes. These tar oils were highly useful during the war in taking the place of lubricating oil from petroleum, and thus they were in a position to keep their large gas machines and motors in operation.

Great hopes are likewise being based on the low temperature distillation of bituminous and brown coal in gas producers, producing new varieties of tar which are good for lubricating and internal combustion motors. This is a very promising field, which has been actively followed up by several German firms and institutes of research.

The technical use of hydrogen gas under pressure appears also to be particularly valuable, such as in the Bergin process of the Consortium for the Chemistry of Carbon and in the tetraline process of the Tetralin G. m. b. H. of Dessau. Tetraline, or tetra hydronaphthalene, is a very useful material, as in the lacquer industry. It has become possible to thus convert solid naphthalene into a fluid hydrocarbon with numerous new applications.

England and America have certainly begun during the war similar developments in carbon chemistry and the utilization of fuels, and it cannot be doubted that this fact alone would make it absolutely necessary for Germany to pay the greatest attention to the progress of science and technology in foreign countries. The former German Minister of Education, von Trott zu Zolz, was therefore quite right when he said, as far back as January, 1917, in his report on the furthering of foreign study, that a greatly increased knowledge of what foreign nations were doing was an absolute necessity. From the present standpoint, such a continuous and close study of foreign methods appears more necessary than ever.

In the present difficult times none of us should grow pessimistic or lose courage for his work; we should see that in the near future our spiritual and material development is going to continue. This is particularly true of the chemical industry of Germany, which before the war was recognized by all the world as pre-eminent. This being so, we should recall the very true words printed by the *North American Review* in 1893, which are well worth quoting in concluding these remarks:

"That country which has the best chemists will eventually become the richest and most powerful. It will possess at the lowest prices the best food, the best manufactures, the best weapons, and lose the least in production. Its people will make the best possible use of the natural resources of their land, because of universal hygiene they will enjoy the best health, and they will be least dependent on other nations for supplying their needs. The instruction of the people in chemistry and other natural sciences is therefore to be regarded as the best investment of a people's capital, since in the future the competition for place among the nations will depend principally on their achievements in scientific and technical chemistry."

The Increased Value of the Taylor System for Post-War Times.—The Jan. 1, 1919, issue of the *Technische Rundschau* contains an interesting article by ENG. WINTERMEYER on the application of the Taylor system for post-war times, with special reference to Germany. He remarks:

The quick and successful application of this system to American industries has given them a great advantage in international competition. To catch up to the Americans in this field, and if possible to surpass them, should be the aim of all who are active in industry and trade.

For reaching the lowest cost of production, it is necessary to divide up the work into as many different parts as possible. Each workman thus becomes highly skilled in a very small field, and gives his whole attention to perfecting it; in other words, he becomes a specialist, with great knowledge and ability in a narrow field. Each workman must be assigned to that particular part of the field for which he has the greatest inclination and aptitude. He must be contented and take pleasure in his work; only thus can the best ends be attained. A skilled workman should never be assigned a task which a less skilled or ordinary laborer can do. The average workman must be relieved as far as possible from unnecessary mental work; this should be done for him by others who are better prepared for it by inclination and education. The scheme therefore involves a fundamental study of each worker to determine his aptitudes and capabilities.

The mental work must be done outside of the workshop, in a particular bureau where a corps of educated men are placed. These do the preliminary researches and calculations leading up to the mechanical work; they are also specialists, giving in each field the best possible service. They are always in close touch with the workman, and when they bring the workmen under their care forward satisfactorily, they are correspondingly rewarded. They therefore work hand-in-hand with the workmen.

In each division of the work, the workmen must be taught to practice simplification and improvement of their particular part. Each working motion must be studied to see if it cannot be done in a simpler and more effective way. Every unnecessary, purposeless movement or action is to be cut out, leaving only the absolutely necessary working motions which can attain the desired end.

A very important part of the system is the standardization of parts. The greatest care is given to selecting the most readily producible parts which go into the construction of a complex article. The question is how far standardized parts can be thus used. If, for instance, a certain system of screws is standardized, then the constructor must endeavor to use these normal forms wherever possible, thus saving time, money and attention. This does not limit the free activities of the designing engineer; the opposite is the case. How important this idea is, is well shown by the recent creation of the Standardization Committee of German Industries.

In actual application of the Taylor system it is absolutely necessary that the individual workman be fully contented; only so can the best results be attained. This is attained most completely on the basis of the manner and amount of payment for work done. This is done absolutely fairly and impartially. A single foreman does not determine the wages, but this is done by the "works bureau," on the basis of their own experiments and experience. This bureau makes most complete investigations of the time necessary to perform the individual movements or operations of which the work consists. These studies form the basis of the time assigned to each piece of work. Adding to this necessary time a certain percentage for rest or relaxation, there results the average time which should be allowed for the operation. The percentage assigned for relaxation must also be studied, and assigned such an amount that the workman can work through his shift without becoming sleepy or exhausted.

The workman who reaches the output thus determined is given high wages; if he exceeds it, still higher, if he comes short, below a certain standard, he is paid accordingly. Whether he reaches the high standard or not depends on his industry and skill. The average workman can produce much more working under the Taylor system, and this improvement is made profitable both to himself and to the employer.

Recent Chemical and Metallurgical Patents

British Patents

Complete specifications of any British patents may be obtained by remitting 25c. each to the Superintendent British Patent office, Southampton Buildings, Chancery Lane, London, England.

High-Speed Tool Steel and Other Steel Alloys.—High-speed tool steels and other alloy steels containing chromium, vanadium, tungsten, titanium, or the like are made by a single aluminothermic reaction of a charge containing aluminum, magnesium, silicon, or like reducing elements, and ores, oxides, or salts of chromium, etc., iron, and carbon, without the use of a separately prepared bath of molten iron or steel. The carbon may be present as ferrochromium or other alloy, and some high-speed or like steel scrap may be used. For example a steel alloy containing carbon, cobalt, chromium, vanadium, tungsten, and manganese may be prepared from a charge containing separately prepared aluminothermic iron, tungsten and cobalt mixtures, wrought iron or mild steel, carbon-free ferrovanadium, and ferrochromium containing about 8 per cent of carbon. (British Patent 123,102—1918. W. L. TURNER, Purley Chase, Atherstone, Warwickshire. April 9, 1919.)

Extracting Metals and Alloys.—Aluminum alloys containing zinc, copper, iron or other metals and 65 to 97 per cent of aluminum, with or without small amounts of magnesium, silicon, calcium, or the like, are used instead of commercially pure aluminum in thermo-aluminic mixtures for use in the manufacture of metals and alloys, or in the production of steel alloys by the process described in Specification 123,102—1918. The aluminum alloys may be melted, cast and crushed. In some cases, part of the aluminum alloy in the mixture may be replaced by pure aluminum, magnesium, silicon, or the like. In using the mixture, the parts of the charge near the points of initiation of the reaction may be more finely divided than the remainder. (British Patent 123,103—1918 W. L. TURNER, Purley Chase, Atherstone, Warwickshire, and H. A. BLACKWELL, Whyte House, Bispham, Blackpool. April 9, 1919.)

High-Speed Tool Steel and Other Steel Alloys.—High-speed tool steel hammerscale is used as an ingredient of the thermo-aluminic mixture for making high-speed tool steel, magnet steel, or other steels containing tungsten, chromium, vanadium, titanium, cobalt, molybdenum, and the like, according to the process described in Specification 123,102—1918. For example, a mixture may be used containing 100 lb. of the scale, 4½ lb. of ferrochromium containing about 60 per cent of chromium and 8 to 10 per cent of carbon, 10 lb. of wrought iron or mild steel, and 28¼ lb. of aluminum. Silicon and manganese, if required in the steel, are added as ferrosilicon and ferromanganese preferably after the thermo-aluminic reaction. (British Patent 123,113—1918. W. L. TURNER, Purley Chase, Atherstone, Warwickshire. April 9, 1919.)

Chrome Steel.—A mild chrome steel containing 12 to 15 per cent chromium and less than 0.1 per cent of carbon, or a rustless chrome steel containing 0.2 to 0.4 per cent of carbon, is produced as described

Specification 123,102—1918, by the thermo-aluminic reaction of a mixture of chrome iron ore or other chromium and iron bearing materials and aluminum, magnesium, silicon, or the like, or scrap aluminum alloy (say 30 per cent aluminum), the mixture containing also, in some cases, some metallic iron and in the case of the second mentioned steel, sufficient carbon. (British Patent 123,104—1918. W. L. TURNER, Purley Chase, Atherstone, Warwickshire. April 9, 1919.)

Ferrochromium.—In the production of carbon-free ferrochromium by the alumino-thermic process, potassium or sodium bichromate or chromate is added to the mixture of chrome iron ore and aluminum or other reducing agent. The mixture may be preheated. (See British Patent 123,104—1918.) (British Patent 123,105—1918. W. L. TURNER, Purley Chase, Atherstone, Warwickshire. April 9, 1919.)

Acetates.—Aqueous solutions of acetic acid are extracted by organic solvents insoluble in water (ex. benzene or toluene) and the extract is neutralized by a solution of basic lead acetate, milk of lime, or alkalis. The solvent is separated from the neutralized solution and used again for extracting the acetic acid solution. The process may be applied to the dilute sodium acetate liquors resulting from the manufacture of chrome yellows from lead acetate; the sodium acetate liquor is acidified with sulphuric acid and extracted with benzene, which is repeatedly circulated between the acid solution and a solution of basic acetate of lead or milk of lime. (British Patent 122,953—1918. E. F. MORRIS, Holly Bank, Roby, near Liverpool. April 9, 1919.)

Obtaining Lead Electrolytically.—Spongy lead, suitable for use in making battery plates, is obtained by electrolyzing a caustic alkali solution with an anode of lead or lead peroxide, for instance an old battery plate, and a cathode of another metal such as zinc and collecting the metal floating at the surface of the electrolyte. The electrolyte may contain 20 per cent of caustic potash. A suitable current density at the anode is 12 amp. per sq.ft. The product is impregnated with hydrogen from the cathode, and may be freed therefrom by compression if desired. It is washed successively in acid and water. (British Patent 123,587—1918. V. G. JOURIEFF, 43 Victoria Road, Chingford, Essex. April 24, 1919.)

Obtaining Metals and Alloys Electrolytically.—In the production of metals and alloys, such as tin, copper and bronze, in the form of paste or sludge, suitable for coating paper, anodes formed partly of the metal and partly of insoluble material such as hard graphite are used to prevent an increase in the quantity of metal in solution. The ratio of the areas of the soluble and insoluble parts of the anode may be adjusted by raising or lowering them. Further regulation may be obtained by immersing in the electrolyte at intervals pieces of the metal, not connected in circuit. The electrolyte may be circulated through a series of vats, the soluble or insoluble anodes being in the same or different vats. Means for regulating the electric current or liquid flow through individual vats may be provided. A heating or cooling coil may be arranged in the liquid path. In the production of tin, the electrolyte may contain 2.5 g. of tin and 50 g. hydrochloric acid per liter; the cathode current density may be 60 amp. per sq.dm.; the ratio of the area of the soluble anode to that of the insoluble anode may be 2 : 4, and the temperature not above 28 deg. C. —say 20-21 deg. C. (British Patent 124,006—1918. B. LEECH, 77 Powell St., Macclesfield, Cheshire, and H. & L. SLATER, Harter St., Manchester. May 7, 1919.)

Phenolaldehyde Condensation Products.—In the production of resinous condensation products from phenols and aldehydes, ammonium salts of volatile organic acids (formic, acetic, propionic, butyric, valeric, etc.), ammonium salts of organic acids which decompose to phenols or cresols, salicylic acid or ammonium bicarbonate are used as condensing agents. The process is carried out by heating the reagents until the condensation product has formed, removing the upper aqueous layer from the product, allowing the residue to stand, and cooling to separate more water, and to drive off all the water. Lime, baryta or magnesia may be added in the last stage to assist in removing the condensing agent. Fatty acids or their salts, resins, gums, waxes, rubber, etc., may be incorporated in the product. (British Patent 124,01—1918. R. E. DIOR, 93 rue Thiers, Boulogne sur Seine, France. May 7, 1919.)

Preparation of Aluminum Chloride and Sodium-Aluminum Chloride.—Calcined clay and sodium or potassium chloride are heated in a rotary furnace to bright redness and vapors of arsenious oxide are passed over, to form sodium or potassium aluminate, silica, and vapors of arsenic trichloride. The aluminate is separated by solution in water, and carbon dioxide is passed through the solution, forming sodium or potassium carbonate, and precipitating alumina. The alumina is mixed with coke and in some cases sodium chloride, and formed into briquettes, which are heated and treated with gases containing chlorine formed from the arsenic trichloride. Aluminum chloride or the double salt sodium-aluminum chloride is formed and distilled. The flue gases containing vapors of arsenic trichloride formed in the first operation are treated with steam to form arsenious oxide, which is condensed by cooling, and hydrochloric acid gas, which is oxidized to yield chlorine by admixture with air and passage over heated catalytic surfaces such as small balls of clay impregnated with copper chloride. The gases containing chlorine are washed with water to remove hydrochloric acid and are dried. (British Patent 123,243—1918. E. E. DUTT and P. C. DUTT, Jubbulpore, Central Provinces, India. April 16, 1919.)

Continuous Zinc Extraction.—The zinciferous ore is mixed with bituminous coal, the mixture subjected to a low-temperature coking, out of contact with air, expelling thereby the superfluous hydrocarbons and water vapors. The mass is powdered and fed at the top of a retort comprising 3 sections. The smelting takes place in the middle section of the retort. The zinc vapors pass out through a branch in the upper section to a condenser in which a hood floats in the metallic zinc and protects it and the fumes from oxidation. The residue from the middle section, which will contain in the metallic form any lead or iron originally present in the ore, etc., passes into the third (lower) section of the retort, from which it may be discharged periodically or continuously, admission of air to the retort being prevented. (British Patent 122,688—1918. J. ARMSTRONG, 5 Victoria St., London, April 2, 1919.)

Publications in Europe and Africa.

A list of newspapers, trade journals and other publications in the principal cities of Europe and Africa has been prepared, from names submitted by American consular officers and representatives of the Bureau, for the benefit of firms interested in foreign advertising. This list may be obtained from the Bureau of Foreign and Domestic Commerce or its district and cooperative offices by referring to file No. 9858.

The Gold Production of Australia.

The gold production of Western Australia continues to show a steady decline. During the six months ended June 30, 1919, the total Australian production amounted to 573,279 fine ounces, of which Western Australia furnished 410,428 oz. For the first six months of 1918 the Australian production was 641,911 oz., the State of Western Australia furnishing 443,983 oz. During the first six months of 1917 the total production amounted to 727,995 oz., of which amount Western Australia furnished 490,466 oz.

It is stated that the cause of this decline is increased working expenses due to high wages and the high cost of machinery and materials. It is not expected that much, if any, improvement can be looked for in the immediate future.

The Chemical Warfare Service.

Senator Chamberlain in his criticism of the Army reorganization bill comments as follows on its failure to continue the Chemical Warfare Service as a separate entity:

"No provision is made in the pending bill for the maintenance of that important service as developed and organized during the recent war, but it is understood that it is the purpose of the Secretary of War to assign it permanently to the Engineer Corps, under the general powers proposed to be conferred upon the President by this bill.

"In consideration of this subject it is of the first importance to bear in mind that such a service must have two separate and distinct functions. One of them is scientific research and the development, production and procurement of necessary materials. The other function is the application of those materials by appropriate troops to military uses, just as the materials developed, produced and procured by the Ordnance Department are applied to military uses.

"These two functions of a Chemical Warfare Service should not be combined in one organization or under one head, because there are no officers in the Engineer Corps or elsewhere in the Army whose training and practical experience as chemists fit them either for the performance or the intelligent supervision of the scientific duties of chemical research and production.

"There should be established in the Army a department of chemistry, along the lines of the Medical and Ordnance Departments, to be filled from top to bottom with expert professional chemists.

"To this department should be assigned all duties pertaining to the scientific research required, and to the development, production and procurement of all materials needed for the purposes of chemical warfare, such materials to be supplied to appropriate troops for application to military uses, including the making of the necessary experiments with regard to such uses.

"To this department should also be transferred, as far as practicable, all work of a chemical nature now done in or under the various bureaus of the War Department."

Personal

Dr. JEROME ALEXANDER, well known for his contributions on colloid chemistry, is confined to his house in the country at Ridgefield, Conn., by illness. The latest reports concerning his condition are favorable.

Lieut. C. H. HAZARD, recently discharged from the Chemical Warfare Service, is now with H. A. Metz & Co., Inc., and the Consolidated Color & Chemical Co., in its purchasing department.

Lieut-Col. ELMER K. HILES, formerly of the Engineers, A.E.F., is now manager of laboratories, Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Mr. JACK J. HINMAN, JR., formerly captain in the Sanitary Corps of the A.E.F., has returned to his pre-war duties as water bacteriologist and chemist to the Iowa State Board of Health and assistant professor of epidemiology in the State University of Iowa.

Mr. JULIUS B. KOHN, formerly employed by the U. S. Public Health Service as organic chemist, doing research work under the direction of Dr. Julius Stieglitz of the University of Chicago, is now connected with the Mallinckrodt Chemical Works, St. Louis, Mo., as research chemist.

Professor GILBERT N. LEWIS, dean of the College of Chemistry, University of California, formerly lieutenant-colonel in the Gas Service, A.E.F., has been decorated Chevalier of the French Legion d'honneur.

Mr. VICTOR E. NELSON, associate in chemistry, Johns Hopkins University, has accepted a position as assistant professor in charge of physiological chemistry at the Iowa State College.

Professor J. E. PETAVEL has been appointed director of the British National Physical Laboratory in succession to Sir Richard Glazebrook, retired. Professor Petavel is professor of engineering and director of the Whitworth Laboratory in the University of Manchester.

Mr. L. E. SAUNDERS, manager of research and abrasives plants, Norton Co., has been transferred to the main executive office at Worcester, Mass. Mr. P. G. SAVAGE becomes assistant to Mr. Saunders as resident manager of the plant at Niagara Falls, N. Y., and Chippawa, Ont., Canada.

Professor NORMAN A. SHEPARD, Yale University, New Haven, Conn., has resigned to enter the employ of the Firestone Tire & Rubber Co.

MR. JEROME STRAUSS, formerly first lieutenant, Inspection Division, Ordnance Department, is now assistant chief chemist and metallurgist, U. S. Naval Gun Factory, Washington, D. C.

Current Market Reports

The Non-Ferrous Metal Market

Monday, Oct. 6.—Little activity is to be found in the nonferrous metal market, but prices are firm and producers willing to carry stocks.

Copper sheets, hot rolled	33½
Copper sheets, cold rolled	35
Copper bottoms	41½
Copper rods	24¾
Copper wire	26
High brass wire & sheets	27¼
High brass rods	26¾
Low brass wire & sheets	30½
Low brass rods	31¾
Brazed brass tubing	39
Brazed bronze tubing	44¼
Seamless copper tubing	37½
Seamless bronze tubing	44¾
Seamless brass tubing	36
Scrap, heavy mach. comp	17 —18
Scrap, heavy and wire	17 —18
Scrap, light and bottoms	15 —16
Scrap, heavy, cut and crucible	19 —20
Scrap brass, heavy	10¼ —10¾
Scrap brass, casting	11½ —12
Scrap brass, light	9¾ —10
Scrap, No 1 clean brass turnings	9¾ —11
Scrap, No. 1 comp. turnings	15¾ —16

Aluminum:—The market remains quiet, small sales of 98-99 per cent ingots continue at 33c. per lb. Cast scrap is selling at 21¼-24½c.; sheet, 21-23¼c.; clippings 23¼-27¼c.

Antimony:—Silver fluctuations are expected to have influence on the Asiatic markets. A spot lot of 50,000 lb. is reported sold at 8c.; small job lots bring 8⅞c.

Copper:—No transactions of importance are reported in copper at the present price of 23½c.

Lead:—There is a steady but small trade in lead at 6¼c. lb. in New York and 6c., East St. Louis. Sheet lead cuts are quoted at 9c. lb. Scrap lead, 5½c. lb.

Tin:—London market is rising. Straits spots are quoted at 55¾c and electrolytic at 54¾c. lb. in New York.

Zinc:—Prices are advancing in East St. Louis. Spot New York is now 7.60c. and St. Louis, 7.25c. lb. Scrap zinc, 5½c lb.

OTHER METALS

Bismuth	lb.	—	$2.95
Cobalt	lb.	2.50 —	3.50
Cadmium	lb.	1.50 —	1.75
Magnesium	lb.	1.75 —	2.10
Mercury	75 lb.		100.00
Nickel	lb.	.41 —	.45
Iridium	oz.		175.00
Palladium	oz.	115.00 —	120.00
Platinum	oz.	110.00 —	115.00
Silver	oz.		1.20⅛

The Iron and Steel Market

By reason of the strike, interest in the iron and steel market centers chiefly upon matters of requirements and supplies, for actual transactions are of small volume. The merchant furnaces are sold far ahead on pig iron, and the steel mills far ahead on finished steel products. Regular consumers are thus covered, subject to uncertainties of delivery on account of the strike, and have no particular occasion to make fresh purchases, while occasional or chance buyers cannot, as a rule, place orders.

The iron and steel strike began Monday, Sept. 22, and in three days had reached practically its height. Plants or districts that were largely affected at the outset went down completely, while those in which the strike did not get a good start succeeded in operating, and generally with gains in employment, so that after a few days more there was a clear cut division. Plants were either closed entirely or were operating practically normal. After the first few days the strike was spreading nowhere, but employment was spreading here and there, so that the strike was losing ground. The gains in employment have been consolidated, and at the end of two weeks of strike the situation is that the East and South are operating practically full, western Pennsylvania is operating practically full, while Cleveland and the Mahoning Valley are down entirely, as is very nearly the whole of the Wheeling district. The next important development will be resumption in the closed regions. That may come soon or may be long deferred. The foregoing summary omits reference to some points or districts developments in which would not be crucial. Cambria at Johnstown, Lackawanna at Buffalo and Colorado Fuel & Iron at Pueblo are down entirely, while the Calumet district is operating at less than one-half and with great difficulty at that.

Pig Iron

Not because they are blast-furnaces, but because in large part they are more or less isolated, the merchant furnaces have been less affected by strike than the steel industry proper. Iron foundries are running as usual, while some steel works are not taking the merchant iron they usually take, and thus on the whole there seems to be an approximate balance whereby the strike does not make merchant pig iron either more plentiful or less plentiful.

Steel Products

The production of finished steel is at not more than about 60 per cent of normal. Even were the curtailment uniform in the various finished steel products, the influence as to producing a scarcity would not be uniform, because industries are in much more urgent need of some products than of others. A review will be undertaken as to supplies and requirements in a number of the finished products.

The case of plates stands by itself, for before the strike there was a large surplus of plate-rolling capacity, due to there being rather an eager demand while plate capacity had been increased very greatly during the war. The eastern Pennsylvania plate mills continued to run with scarcely any curtailment, but from Cambria at Johnstown and Lackawanna at Buffalo westward there was almost complete closing of plate mills except for Homestead and a few small plants, even Jones & Laughlin being considerably affected. The result is that plates are now a trifle scarce.

At the other extreme is the case of oil country goods, involving practically the output of the lap weld departments of the pipe mills. The strike is geographical and it chances that four important independents, easily the bulk of the independent production, are closed, Republic and Youngstown Sheet & Tube at Youngstown, La Belle at Steubenville and Wheeling Steel & Iron in the Wheeling district. The National Tube Co., on the other hand, is but little affected. It lost its Riverside plant in the Wheeling district, of course, but little else. Its largest plant, McKeesport, ran fairly well, and its next largest, Lorain, was unaffected, although only a few miles from Cleveland, where everything went down. Of two smaller plants in Pittsburgh, Continental stayed in operation and Pennsylvania went down for a few days, afterward beginning to recover. Altogether, the production of pipe was curtailed by 50 per cent at the lowest estimate, yet before the strike there was an acute scarcity of oil country goods, so much so that many lessees in the Texas field were almost certain to lose their leases through being unable to drill wells within the time they had injudiciously set.

The strike was proposed as if it were to be primarily a strike against the United States Steel Corporation, yet it has just been indicated that in pipe the independents experienced more strike than the Steel Corporation. The same was true in the case of sheets, yet the divergence in each case is due chiefly to geography. The fact is, of course, that the agitators simply aimed to produce all the strike they could, their plans succeeding in some places and not in others. After ten days of the strike the American Sheet & Tin Plate Co. was operating 72 per cent of its sheet mills, while not more than 50 per cent of the independent sheet mills were operating. Of the Steel Corporation sheet plants, seven were operating in full. The Steel Corporation sheet plants chanced to be widely distributed, many being in towns where there were no other plants. The independent sheet industry is centered largely in the Mahoning Valley, which next to Wheeling is traditionally the worst strike district in the industry. Sheet mills making specialties were not closed in altogether as great proportion as mills making common sheets, and thus makers of automobiles, metal furniture, etc., are in line to be incommoded somewhat less than users of common sheets.

Much more than half of both the Steel Corporation and the independent tin plate mills were closed by the strike. While as a rule skilled workmen had little to do with the steel strike except through being thrown out of employment by the common labor striking, in the case of tin mills there was no small amount of striking by tonnage men. The curtailment in tin plate production is of very small moment when contrasted with conditions in other finished steel products, the canning season being over. In normal years tin plate production is lighter at this season than at any other in the year.

Production of plain wire and wire products is greatly curtailed in the case of both Steel Corporation and independents, but the fall distribution to jobbers had been completed and the pressure for mill deliveries at this time of year is not heavy. Jobbers' stocks were relatively light. The mills operating, however, should keep the country moderately well supplied even should the strike in general be prolonged for several weeks.

Prices

There are many steel producers who are prone to seize upon every argument that may be marshaled in favor of advancing prices. That is not so much because steel producers are always wanting to make more money as because it has been a sort of custom in past years to run the market by advancing prices and thus encourage buyers to make contracts. At the present time there is no talk of advancing prices, not simply because the market is not being discussed, but because it is recognized that it would be bad form in the circumstances. Producers note with interest Judge Gary's remark before the Senate committee investigating the steel strike that prices are high enough already and it would be better for prices generally to come down.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, OCT. 8, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.55 – $0.60
Acetone	lb.	$0.13½ – 0.14	.15 – .15½
Acid, acetic, 28 per cent	cwt.	2.50 – 3.00	3.00 – 3.25
Acetic, 56 per cent	cwt.	5.00 – 5.50	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00 – 12.50	12.90 – 13.50
Boric, crystals	lb.	.13 – .13½	.13½ – .14
Boric, powder	lb.	.13 – .13½	.13½ – .14
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	1.50 – 1.75	2.00 – 2.50
Hydrofluoric, 52 deg.	lb.	.12 –	.14 –
Lactic, 44 per cent. tech	lb.	.11 – .14	.12 – .16
Lactic, 22 per cent. tech	lb.	.05 – .06	.05½ – .07
Molybdic, C. P.	lb.	–	4.00 – 4.25
Nitric, 40 deg.	lb.	.06 – .06½	.07 – .08½
Nitric, 42 deg.	lb.	.07 – .07½	.08 –
Oxalic, crystals	lb.	.23 – .25	.25 – .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 –	.10 – .14
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	–	2.30 – 2.60
Sulphuric, 60 deg., tank cars	ton	12.00 – 16.00	–
Sulphuric, 60 deg., drums	ton	17.00 –	22.00 –
Sulphuric, 60 deg., carboys	ton	20.00 –	25.00 –
Sulphuric, 66 deg., tank cars	ton	17.00 – 18.00	22.00 – 23.00
Sulphuric, 66 deg., drums	ton	20.00 – 21.00	25.00 – 26.00
Sulphuric, 66 deg., carboys	ton	25.00 –	30.00 – 40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 –	27.00 –
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 –	32.00 –
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 –	35.00 –
Tannic, U. S. P.	lb.	–	1.35 – 1.45
Tannic (tech.)	lb.	–	.42 – .55
Tartaric, crystals	lb.	–	.74 – .77
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl	gal.	4.80 –	4.95 –
Alcohol, Methyl	gal.	1.30 –	1.33 – 1.38
Alcohol, denatured, 188 proof	gal.	.56 –	.58 – .60
Alcohol, denatured, 190 proof	gal.	.52 –	.54 – .56
Alum, ammonia lump	lb.	.03½ – .04½	.04½ – .04¾
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .02¾
Aluminum sulphate, iron free	lb.	.02½ – .03	.03½ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08 –	.08½ – .08¾
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	–	.30 – .35
Ammonium carbonate, powder	lb.	.13 – .13½	.14 – .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½ – .13	.13½ – .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 – .12½	.13 – .13½
Ammonium nitrate	lb.	.10 –	.11 – .12
Ammonium sulphate	lb.	.05 –	.06 –
Amyl acetate	gal.	–	3.75 – 4.00
Arsenic, oxide, lumps (white arsenic)	lb.	–	.09 – .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	–	–
Barium chloride	ton	85.00 –	90.00 – 100.00
Barium dioxide (peroxide)	lb.	.22 –	.24 –
Barium nitrate	lb.	.10 – .10½	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.03½ – .04
Bleaching powder (see calcium hypochlorite)		–	–
Blue Vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	–	.65 – .75
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	–	.04 – .05
Calcium chloride, fused, lump	ton	19.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	2.25 – 2.50	– 2.75
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 –
Calcium sulphate, precipitated	lb.	–	.09 – .09½
Carbon bisulphide	lb.	.05½ –	.06 –
Carbon tetrachloride, drums	lb.	.10 – .11	.12 – .14
Carbonyl chloride (phosgene)	lb.	–	.75 –
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.08 –
Cobalt oxide	lb.	–	1.50 – [illegible]
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	–	.28 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .08¾	.09 – .09½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Formaldehyde, 40 per cent	lb.	–	.22½ – .24
Glauber's salt (see sodium sulphate)		–	–
Glycerine	lb.	–	.19 – .21
Iodine, resublimed	lb.	–	4.50 –
Iron oxide, red	lb.	–	.03 – .20
Iron sulphate, (copperas)	cwt.	1.00 –	1.20 – 1.50
Lead acetate, normal	lb.	–	.12½ – .14½
Lead arsenate (paste)	lb.	–	.13 – .17
Lead nitrate, crystals	lb.	–	.85 – .86½
Litharge	lb.	–	.09 – .10½
Lithium Carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	–	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	2.00 – 2.63	2.75 – 3.00
Magnesium sulphate, commercial	100 lb.	1.75 –	2.00 – 2.50
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.12 –	.15 – .16
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	–	.60 – .70
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.28 – .30	–
Potassium bitartrate (cream of Tartar)	lb.	–	.55 – .60
Potassium bromide, granular	lb.	–	– .60
Potassium carbonate, U. S. P.	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.19 –	.21 –
Potassium chlorate, crystals	lb.	.20 – .24	.25 – .30
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.30 – .32	.35 – .40
Potassium iodide	lb.	–	3.55 – 3.60
Potassium nitrate	lb.	.12 –	[illegible] –
Potassium permanganate	lb.	–	[illegible] – .65
Potassium prussiate, red	lb.	–	[illegible] – 1.15
Potassium prussiate, yellow	lb.	–	.45 – .55
Potassium sulphate	ton	225.00 –	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake (sodium sulphate)	ton	17.00 – 21.00	–
Silver cyanide	oz.	–	1.19 –
Silver nitrate	oz.	–	.69½ – .70½
Soda ash, light	100 lb.	1.90 –	2.00 –
Soda ash, dense	100 lb.	2.25 –	2.50 – 2.75
Sodium acetate	lb.	.05½ – .06½	.07 – .08
Sodium bicarbonate	100 lb.	2.35 –	2.75 – 3.00
Sodium bichromate	lb.	.12½ –	.12½ – .13
Sodium bisulphate (nitre cake)	ton	3.00 – 8.00	10.00 –
Sodium bisulphite	cwt.	1.80 – 1.90	2.00 – 2.10
Sodium borate (borax)	lb.	.07½ –	.08 – .08½
Sodium carbonate (sal soda)	100 lb.	1.35 – 1.50	1.50 – 1.75
Sodium chlorate	lb.	.15 –	.16 – .18½
Sodium cyanide	lb.	.30 –	.31 – .34
Sodium fluoride	lb.	.14 –	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	3.30 – 3.40	3.45 – 3.50
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.14 – .17	– .18
Sodium peroxide, powdered	lb.	–	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.43 – .45½
Sodium prussiate, yellow	lb.	.21 –	.22 –
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.03½ – .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.15 – 1.25	1.50 – 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	–	.05 – .06
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.25 –	.28 –
Sulphur chloride	lb.	.05½ –	.06 –
Sulphur, crude	ton	22.00 –	–
Sulphur dioxide, liquid, cylinders	lb.	–	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.10 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 –	3.15 – 3.40
Tin bichloride (stannous)	lb.	.44 –	.46 – .50
Tin oxide	lb.	–	.60 –
Zinc carbonate, precipitate	lb.	–	.20 –
Zinc chloride, gran.	lb.	.12½ –	.13½ – .14
Zinc cyanide	lb.	.49 –	.50 –
Zinc dust	lb.	.09 – .11	.11 – .14
Zinc oxide, dry American	lb.	–	.09½ – .09¾
Zinc sulphate	lb.	.03½ – .03¾	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	— $1.10
Alpha naphthol, refined	lb.	1.40	— 1.50
Alpha naphthylamine	lb.	.32	— .50
Aniline oil, drums extra	lb.	.32	— .33
Aniline salts	lb.	.32	— .35
Anthracine, 80% in drums (100 lb.)	lb.	.90	— 1.00
Benzaldehyde (f.f.c.)	lb.	1.00	— 1.15
Benzidine, base	lb.	1.00	— 1.25
Benzidine, sulphate	lb.	.90	— 1.15
Benzoic acid, U. S. P.	lb.	.90	— 1.10
Benzoate of soda, U. S. P.	lb.	.85	— 1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.32	— ...
Benzol, 90%, in drums (100 lb.)	gal.	.24	— .28
Benzyl chloride, 95-97%, refined	lb.	.35	— .40
Benzyl chloride, tech	lb.	.25	— .35
Beta naphthol benzoate	lb.	3.75	— 4.50
Beta naphthol, sublimed	lb.	.75	— .80
Beta naphthol, tech	lb.	.45	— .55
Beta naphthylamine, sublimed	lb.	2.25	— 2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	— ...
Ortho-cresol, in drums (100 lb.)	lb.	.23	— .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85	— .90
Cresylic acid, 95-97%, dark, in drums	gal.	.80	— .85
Cresylic acid, 50%, first quality, drums	gal.	.60	— ...
Dichlorbenzol	lb.	.07	— .10
Diethylaniline	lb.	1.40	— 2.25
Dimethylaniline	lb.	.55	— .60
Dinitrobenzol	lb.	.26	— .37
Dinitroclorbenzol	lb.	.25	— .30
Dinitronaphthaline	lb.	.45	— .55
Dinitrophenol	lb.	.33	— .36
Dinitrotoluol	lb.	.38	— .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	— .65
Diphenylamine	lb.	.58	— .75
H-acid	lb.	1.60	— 1.75
Metaphenylenediamine	lb.	1.15	— 1.80
Monochlorbenzol	lb.	.12	— .15
Monoethylaniline	lb.	1.50	— 1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	— .08
Naphthaline, flake	lb.	.06½	— .07½
Naphthaline, balls	lb.	.08½	— .10
Naphthionic acid, crude	lb.	.75	— 1.25
Nitrobenzol	lb.	.14	— .19
Nitro-naphthaline	lb.	.35	— .45
Nitro-toluol	lb.	.27	— .20
Ortho-amidophenol	lb.	3.00	— 4.25
Ortho-dichlor-benzol	lb.	.15	— .20
Ortho-nitro-phenol	lb.	.90	— 1.25
Ortho-nitro-toluol	lb.	.25	— .40
Ortho-toluidine	lb.	.25	— .45
Para-amidophenol, base	lb.	2.50	— 3.50
Para-amidophenol, HCl	lb.	2.50	— 3.25
Para-dichlor-benzol	lb.	.15	— .18
Paranitraniline	lb.	.95	— 1.10
Para-nitro-toluol	lb.	1.35	— 1.50
Paraphenylenediamine	lb.	2.50	— 4.00
Paratoluidine	lb.	1.50	— 2.50
Phthalic anhydride	lb.	1.50	— 2.15
Phenol, U. S. P., drums (dest.). (240 lb.)	lb.	.16	— .17
Pyridin	gal.	2.50	— ...
Resorcin, technical	lb.	3.50	— 3.75
Resorcin, pure	lb.	6.50	— 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.37	— .45
Salicylic acid, U. S. P.	lb.	.45	— .50
Salol	lb.	.90	— .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.20	— .27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.18	— .24
Sulphanilic acid, crude	lb.	[illegible]	— [illegible]

Tolidine	lb.	$1.70	—	$2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.26	—	.....
Toluol, in drums	gal.	.27	—	.30
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.23	—	.27
Xylol, commercial, in tank cars	gal.	.22	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.42	—	$0.44
Beeswax, refined, yellow	lb.	.46	—	.88
Beeswax, white pure	lb.	.64	—	.66
Carnauba, No. 1	lb.	.85	—	.88
Carnauba, No. 2, regular	lb.	.67	—	.80
Carnauba, No. 3, North Country	lb.	.48	—	.50
Japan	lb.	.18	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	...
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.06	—	...
Paraffine waxes, refined, 118-120 m.p	lb.	.07	—	.08
Paraffine waxes, refined, 128-130 m.p	lb.	.09	—	...
Paraffine waxes, refined, 133-135 m.p.	lb.	.10½	—	.11½
Paraffine waxes, refined, 135-137 m.p	lb.	.12	—	.13½
Stearic acid, single pressed	lb.	.26	—	.28
Stearic acid, double pressed	lb.	.27	—	.29
Stearic acid, triple pressed	lb.	.31	—	.33

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.10
Pine oil, pure, dest. dist	gal.	.96
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.34
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.85
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.30
Pinewood creosote, ref	gal.	.48

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$16.25	—	$17.50
Rosin E-I	280 lb.	17.00	—	19.25
Rosin K-N	280 lb.	20.50	—	23.00
Rosin W. G.-W. W	280 lb.	24.00	—	24.25
Wood rosin, bbl	280 lb.	16.00	—	17.00
Spirits of turpentine	gal.	1.70	—	....
Wood turpentine, steam dist	gal.	1.50	—	....
Wood turpentine, dest. dist	gal.	1.48	—	....
Pine tar pitch, bbl	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	13.50	—	14.25
Retort tar, bbl	280 lb.	14.50	—	14.90
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.95	—	1.07
Rosin oil, fourth run	gal.	1.05	—	1.10

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.52	—	$0.52½
Upriver coarse	lb.	.31	—	.32½
Upriver caucho ball	lb.	.32	—	.32½
Plantation—First latex crepe	lb.	.49½	—	.50
Ribbed smoked sheets	lb.	.48½	—	.49
Brown crepe, thin, clean	lb.	.43½	—	.44
Amber crepe No. 1	lb.	.47	—	.48

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.18	—	$0.19
Castor oil, AA, in bbls	lb.	.21	—	.22
China wood oil, in bbls	lb.	.22	—	.23
Cocoanut oil, Ceylon grade, in bbls	lb.	.17½	—	.18
Cocoanut oil, Cochin grade, in bbls	lb.	.19	—	.20
Corn oil, crude, in bbls	lb.	.17	—	.23
Cottonseed oil, crude (f.o.b. mill)	lb.	.17½	—	.19
Cottonseed oil, summer yellow	lb.	.22	—	.24
Cottonseed oil, winter yellow	lb.	.22	—	.25
Linseed oil, raw, car lots	gal.	1.75	—	....
Linseed oil, raw, tank cars	gal.	1.65	—	1.70
Linseed oil, boiled, car lots	gal.	1.70	—	1.75
Olive oil, commercial	gal.	2.40	—	2.50
Palm, Lagos	lb.	.17	—	.17½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16	—	.17
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.20	—	.21
Peanut oil, refined, in bbls	lb.	.23	—	.25
Rapeseed oil, refined in bbls	gal.	1.50	—	1.60
Rapeseed oil, blown, in bbls	gal.	1.57	—	1.70
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.17½	—	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.14½	—	.15

FISH

Winter pressed Menhaden	gal.	$1.28	—	.....
Yellow bleached Menhaden	gal.	1.30	—	$1.31
White bleached Menhaden	gal.	1.32	—	.....
Blown Menhaden	gal.	1.34	—	1.38

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00	—	$36.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	35.00	—	47.50
Casein	lb.	.16	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English light	lb.	.04½	—	.06
Chalk, English, dense	lb.	$ .04	—	$ .05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	12.00	—	16.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	30.00	—	$35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	30.00	—	40.00
Fuller's earth, imported, powdered	ton	.....	—	.....
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	1.00	—	....
Shellac, D. C.	lb.	.....	—	....
Shellac, V. S. O.	lb.	.....	—	....
Shellac, Diamond I.	lb.	.....	—	....
Shellac, orange, fine	lb.	1.05	—	.....
Shellac, orange, superfine	lb.	1.10	—	1.30
Shellac, A.C. garnet	lb.	1.00	—	.....
Shellac, bleached, bone dry	lb.	1.25	—	.....
Shellac, bleached, fresh ground	lb.	1.20	—	.....
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	55.00	—	60.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	net ton	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.25	—	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70	—	.....
Ferro-manganese, 70-80% Mn	gross ton	105.00	—	115.00
Spiegeleisen, 16-20% Mn	gross ton	35.00	—	36.00
Ferro-molydenum, per lb. of Mo	lb.	2.50	—	3.00
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, $C_2.O_3$	unit	$0.60	—	$0.80
Chrome ore, 48% and over	unit	.90	—	1.00
Coke, foundry, f.o.b. ovens	net ton	5.50	—	6.00
Coke, furnace, f.o.b. ovens	net ton	4.00	—	5.00
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines	net ton	20.00	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	.....	—	.....
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.13	—	.....
Pyrites, foreign, fine	unit	.13	—	.....
Pyrites, domestic, fine	unit	.14	—	.17½
Ilmenite, 52% TiO_2, f.o.b. N. Y.	net ton	40.00	—	.....
Rutile, 95% TiO_2, f.o.b. N. Y.	net ton	200.00	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free, f.o.b. N. Y.	net ton	135.00	—	.....
Monazite, per unit of ThO_2, f.o.b. N. Y.	unit	42.00	—	.....

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	15.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	55.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	43.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	60.00-70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	1 80
Linseed oil, 5 gal. cans	gal.	1 93
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. fo 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

E. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor

CHEMICAL
& METALLURGICAL
ENGINEERING
A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors
L. W. CHAPMAN
Western Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, October 15, 1919 *Number* 9

Chemists and Labor Unions

WE ARE informed that chemists and assistants on the staff of the Health Department of New York City have joined the Union of Technical Men, affiliated with the American Federation of Labor. With all appreciation of the American Federation of Labor and with due respect for the chemists and assistants on the staff of the New York Health Department, we think the latter should be ashamed of themselves. They occupy posts of grave responsibility, and they have turned over the ordering of their work to an irresponsible authority. If a strike should be called among them the health of over five million people would be put in jeopardy while the single problem of their pay or their hours or their recognition as a body was in process of settlement. Whether such an outrageous act is recorded as a crime on our statute books or not, the fact remains that such a strike would be criminal in the highest degree.

We hold no brief against labor unions or against collective bargaining for labor, either skilled or unskilled. But a professional man, in taking up his profession, assumes responsibilities beyond his daily wage. His education has cost either this or some other community more than he paid for it, and that is the least of his obligations to make good. In entering the service of the city he can stay as long as he likes and leave it whenever he can better himself. But for him to join a labor union and to use a labor union's medium of the strike, whereby a great community is threatened with infection and disease for the sole purpose of improving the conditions of his precious self, is getting things entirely out of focus. He isn't worth it and he should know it. And if he had the slightest sense of professional obligation he would know it.

The President's Industrial Conference

NO APOLOGY is necessary for devoting space in technical and engineering journals to the proceedings of the President's Industrial Conference at Washington. Not only are engineers and technical men everywhere in duty bound to inform themselves on industrial problems, but there is sufficient evidence that the daily press does not always reflect the proceedings of such a conference as an engineer would see them. If reasons are needed, these are ample. Furthermore, the technical press has its share of the responsibility in keeping the thought of the country straight and sane on what is undoubtedly the most momentous problem before us today—satisfactory industrial relations.

The President's Industrial Conference is designed to be representative of the three parties in interest in industrial disputes, viz., Labor, Capital and the Public; or as they may be otherwise designated, Employees, Employers and the Public. It must be evident how difficult a task confronted the President in appointing such a conference, and probably his failure to select a thoroughly representative group was no greater than would have been experienced by anyone else essaying the task. But the fact remains that in the Conference Labor represents organized bodies only, and can by no stretch of the imagination be expected to express the concrete thought of the employees of the country. Labor is the only unified group in the Conference, but it is so because it comprises only members of unions. The Employers are more diverse in their interests, but here too there is lack of representation from many branches of industry. Finally, the Public is represented by a mixed group of Presidential appointees who come from many walks of life and are probably more representative of the people's thought than either of the other groups. Comment is openly made, however, that the Public Group has distinct sympathies toward Labor in its demand for more recognition of the worker and more equitable distribution of industrial production.

The first week of the Conference can scarcely inspire confidence in the hope that it will accomplish something constructive for the industrial life of the nation. Two things are evident: In the opinion of many, as expressed openly in the conference by Dr. ELIOT of the Public Group, Labor has not brought forward any distinctly new or progressive measures for consideration. Labor's proposals are those with which we have been familiar for many years, couched in the same old language and not fundamental in their scope. They are the same "demands" that have formed the basis of combat in years past, and can be designed only to strengthen the means of combat in the future. Second, the introduction of a resolution to have the Conference investigate and settle the steel strike is generally regarded as ill advised and likely to prove a bone of contention that will threaten the usefulness of the Conference in devising a constructive program of industrial relations.

In our judgment the steel strike resolution should not have been introduced, because it is not germane to the purposes of the Conference and can only cause endless wrangling. Under the rules of the Conference there is not the slightest chance of a favorable vote on it, and an adverse vote may prove disastrous to further constructive work. Just what purpose Labor may have in bringing the matter forward at this time is not for us to say; but it is not difficult to surmise that the leaders seek thereby to divert public sympathy to the strike instead of from it, which latter is now the acknowledged trend. By offering to have the Conference adjudicate the strike, Labor can assume a maganimous attitude before the country and can likewise play the role of martyr if the resolution is voted down, which it certainly will be if a vote is reached. On the other hand, should the Conference adopt the resolution, and should the strike be adjudicated in favor of the strikers, organized labor can find little for self-congratulation, because the strike is known to be the work of radicals within the labor movement, who would construe success as approval of their leadership. Nothing could be worse for Labor as a whole.

Control of Large Corporations And of Large Labor Unions

CONGRESS should give careful thought to the suggestion of Judge GARY, chairman of the Steel Corporation, before the Senate Committee on Education and Labor, investigating the iron and steel strike. Judge GARY expressed the opinion that concentrated capital should be under supervision and control of a Federal commission and that concentrated labor should be subjected to control of the Government and of the law.

This statement is carefully put. Is it saying something to assert that concentrated labor should be subject to the law? It is. Twenty-seven years ago Judge PAXSON, Chief Justice of the Supreme Court of Pennsylvania, selected, on account of the importance of the case, to charge the Grand Jury at Pittsburgh in the case against the Homestead strikers of 1892, said:

"It was not a cry for bread to feed their famished lips; the result of sudden outrage, with good provocation; it was a deliberate attempt of men without authority to control others in the enjoyment of their rights. The existence of such a state of things, in a government of law, indicates a weak spot somewhere. It is not in law itself. That is sufficient for the preservation of order; all that is needed is its proper enforcement."

Since Justice PAXSON delivered those words there has been no improvement, as shown by the wholesale lawlessness in the iron and steel strike that began September 22. The lives of wives, mothers and children have been threatened, and there have been threats that homes would be burned in hundreds, possibly thousands, of cases, just for the purpose of keeping men from working. Mobs have marched from a striking plant to another that was operating and have gotten the men out, simply at the time the shifts changed. It seems to be a fair estimate that of the men employed in the iron and steel industry 10 per cent wanted in advance to strike; 20 per cent were inclined to strike when the time came, and 20 per cent were put out of employment by intimidation, making 40 per cent idle altogether. Some plants and some districts were closed entirely, others operated in full or in large part. The difference was made by two things, the difference in distribution of the men who wanted to strike, and the difference in the amount of protection afforded by the civil authorities.

Public sentiment has been largely responsible for this state of affairs. Justice PAXSON referred to that also, in his charge of 27 years ago. There is more sympathy for the man who wants to strike than for the man who wants to work. The morals of the public are very lax, and sympathy for the striker develops into a disposition to condone lawless acts.

There is a reason, however poor, for everything, and there is a reason for this state of the public mind. It is the notion that somehow or other the wage earner is at a disadvantage and is entitled to some extra consideration. Granting that such may be the case sometimes, it is equally possible for the wage earner to have an undue advantage. The pendulum may swing so far that injury will be caused everyone, for if men get too high wages and work too little they will eventually suffer and the public will certainly suffer through having to pay too much for goods, while capital may be destroyed. The public was given some very good food for thought in the Boston policemen's strike.

Why should it be difficult for us all to adopt the conception that the man and the job are equally important, that each has in essence what amounts to an undivided half interest in prosperity, that either is useless without the other?

There was fear at one time that large aggregations of capital were inimical to the public interest. Experience has shown that large corporations are amenable to public opinion, and indisposed to misuse the power they possess. Experience, and particularly recent experience, shows that large aggregations of workmen are disposed to misuse their power, to the extent of trampling on the law wherever they think it to their advantage. Whether the one requires control more than the other need not be debated. Let Congress simply decide that both must be controlled, and let it be made known universally, by whatever medium or means necessary, that the laws must be obeyed and that in a labor contest men have no license to disregard the law.

Readers' Views and Comments

H. R. Bills 5011, 5012 and 7010, 66th Congress, First Session

To the Editor of Chemical & Metallurgical Engineering

SIR: The above bills in relation to patents were drawn by a carefully selected committee of the Research Council. They provide for a separate Patent Court of Appeals, to be established in Washington, consisting of a Chief Justice, appointed by the President for life, and six Assistant Justices, to be appointed for respective terms of six years, by the Chief Justice of the U. S. Court of Appeals, from among the U. S. Circuit Judges. By this means it is hoped to shorten patent litigation; an inventor or owner of a patent without unlimited capital may nevertheless secure his rights. Our present method of providing for this in nine U. S. circuit courts of appeal, of concurrent jurisdiction but limited territorial authority, makes this exceedingly difficult.

Another provision raises the salaries of the staff to a range commensurate with that provided for the staffs of other departments. This principal examiners are to receive $4000 instead of $2000, as at present; and various grades of assistant examiners are to be increased in proportion. The integrity and technical competence of these men, numbering several hundred, constitute the key to our patent organization. Every neglect, every error, in regard to important inventions, is fraught with heavy costs for litigation, which, in the end, the public must pay. Such defects also make for disorder and confusion. The entire increase, as I recall it, involves between $900,000 and $1,000,000 per year. I believe a considerable part of this would be defrayed by the fees taken in response to a better patent situation. Under present conditions, at the existing rates of pay, the Commissioner cannot maintain an adequate standard of technical capacity in his staff.

Another provision authorizes the court to determine upon a reasonable royalty in the case of infringement. It is very rare that the owner of a patent can give the exact measure of the damages incurred through infringement by his opponent, inasmuch as a single patent seldom covers the whole of an article which is made and sold under infringement. The usual award in such cases is six cents to a successful contestant for his patent rights where these are proved.

Still another provision removes the Bureau from the jurisdiction of the Secretary of the Interior, and makes it a separate bureau. Under existing conditions the Honorable Secretary of the Interior has in substance no authority over the Bureau to make changes in organization or procedure, although his approval is required for these.

I respectfully urge on your favorable consideration the bills above mentioned. E. P. O.

New York City.

The Design of Electric Furnaces

To the Editor of Chemical & Metallurgical Engineering

SIR: In your issue of Sept. 1 you have an article by R. C. Gosrow entitled "The Design of Electric Furnaces." Mr. Gosrow in his article refers to an article of mine originally appearing in the Transactions of the A.I.M.E. which you abstracted. In looking over Mr. Gosrow's article I find on page 238 tabulated details with reference to a certain furnace. It is there stated that with a 1650 kw. input his furnace produced 16 tons of 81.5 per cent ferromanganese daily from ores of which he gives an analysis.

I wish to call your attention to the fact that this is an impossibility. Were it true it would mean that the furnace produced ferromanganese for something like 2360 kw-hr. per ton. The lowest figure that I have ever seen is 4000 kw.-hr. per ton of metal, and this is open to some question. I have been interested in figuring the theoretical power consumption in the case of this furnace and find that it would require about 6500 kw-hr. per ton. Is the 16 tons a misprint?

E. S. BARDWELL.

Great Falls, Mont.

To the Editor of Chemical & Metallurgical Engineering

SIR: Mr. E. S. Bardwell's comment on my article in the Sept. 1 issue of CHEMICAL & METALLURGICAL ENGINEERING is not without justification. My original figures were compiled from furnace reports and data. The tonnages of alloy and the consumption of energy show an average kilowatt-hour consumption per ton of alloy of 2860. The figures as given in my report and article are correct for furnace load, and the error undoubtedly occurred through transposing the reports into the figures for this article. This then shows an average tonnage for the period of 13½ net tons, which is what the average from the actual tonnages shows.

I do not doubt Mr. Bardwell's statement that 4000 kw-hr. is open to question when other reducing agents are used than charcoal or coke, and running an excessively hot top furnace.

I cannot check Mr. Bardwell's figures for theoretical power consumption at about 6500 kw-hr. for this furnace. R. C. GOSROW.

Seattle, Wash.

The American Academy of Arts and Sciences has voted an appropriation of $300 to Professor Frances G. Wick of Vassar College to aid her in research on the phosphorescence of hexagonite and of fluorite at ordinary and low temperatures, and to Dr. R. W. Wood, professor of experimental physics at Johns Hopkins, $350 in addition to former appropriations for continuation of optical investigations.

Six thousand dollars has been given to Columbia University for special research in food chemistry.

Western Chemical and Metallurgical Field

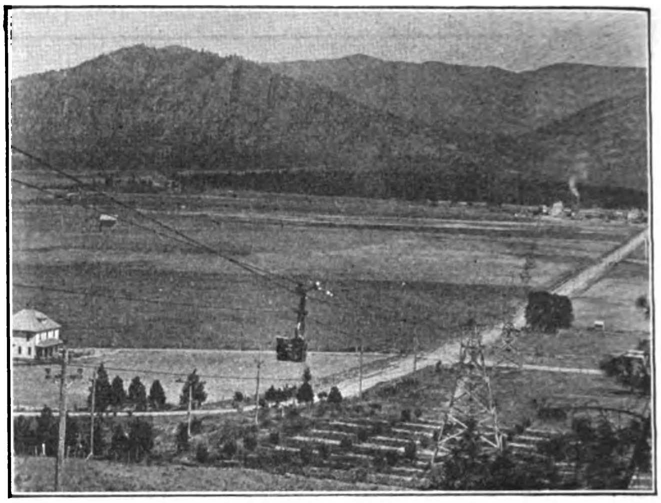
Northwest Magnesite Co.

The company quarries from a large deposit of crystalline magnesite near the town of Chewelah, in Stevens County, Washington, about 60 miles north of Spokane. The mineral occurs as a replacement of lenses of dolomite in sedimentary rocks, in which are found dolomite, shale and quartzite, and into which basic igneous rocks have been intruded. A large portion of the deposit has been diamond-drilled to a depth of 300 ft. By this means data have been obtained for classifying the deposit in sections, depending upon lime and silica content. About a million tons of high-grade mineral has been explored by drilling. Owing to the thickness of the high-grade deposits, it is unnecessary to employ manual methods for selecting ore during or after mining.

At the present time, the bulk of the mineral is being taken from an open quarry near the top of a ridge known as Finch Quarry, whence it is lowered by an aërial tramway to a crushing plant near the foot of the ridge. The crushing plant consists of a large jaw crusher which takes the mineral as quarried and delivers it to one of a set of two gyratory crushers, which reduce it to 2-in. size and deliver it to the storage bins at the tramway head. From these bins the mineral is transported by an aërial tramway five miles in length and delivered into the crushed mineral storage bins at the calcining plant. The storage bins have a capacity of 800 tons, which is sufficient to supply the plant 24 hours. The entire operation of quarrying, crushing and transporting being mechanical, the crushed mineral is delivered to the storage bins at the calcining plant at a minimum cost.

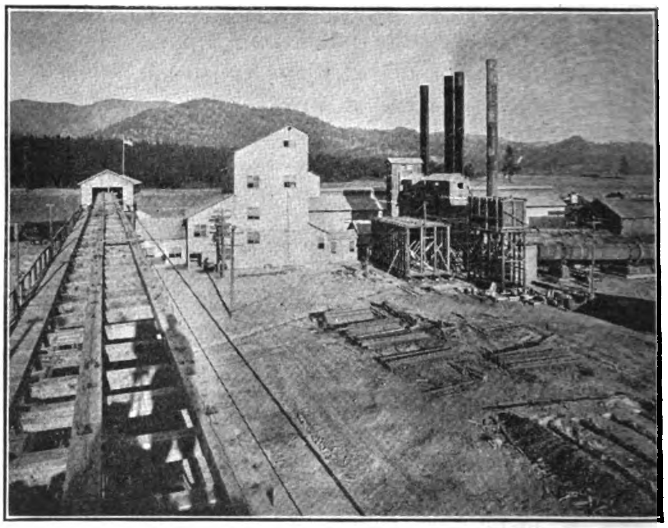
FINCH QUARRY

The first operation at the calcining plant is a further reduction of the mineral by means of a set of rolls; this final product will all pass through a 10-mesh and about 20 per cent will pass through a 100-mesh screen. The proportion of the fine material in the crushed mineral is important, as it assists materially in producing a uniform product as a result of the reaction between the iron oxide and the magnesite in the rotary kiln. The crushed mineral is weighed in 1-ton batches and to each batch is added about 40 lb. of finely pulverized high-grade magnetite (iron oxide). The weighed materials are delivered to, and thoroughly incorporated by, a rotary mixer, from which the product is delivered by means of an elevator and conveyor to storage bins at the head of the rotary kilns.



AERIAL TRAMWAY

The rotary kilns, of which five are installed, are 125 ft. in length, 7 ft. 6 in. in diameter; they are lined throughout with 9-in. No. 1 fire clay brick. Powdered coal of a sub-bituminous type obtained from a nearby mine is used for fuel, being supplied to the kiln by a Bonnet pulverized-coal-system of 150 tons daily capacity. About 700 lb. of coal containing 12,000 B.t.u. per lb. is required to produce one ton of ferromagnesite. Each kiln has a maximum capacity of 70 tons of dead-burned magnesite per day. About 2.2 tons of raw material is required per ton of finished product. The incandescent ferromagnesite emerging from the kilns is cooled by passing through revolving air-cooled steel tubes; it is then crushed by rolls and sorted by screens into sizes required by the trade. The ferromagnesite building has storage capacity for 1000 tons of finished product and is located on a spur track, loading being direct into cars. The process of manufacture from the crushed ore storage bins to the finished product storage is continuous.



CALCINING PLANT

President's Industrial Conference Meets in Washington

Three Groups, Representing Labor, the Public and Employers, Convene to Reach, if Possible, Some Common Ground of Agreement and Action With Regard to the Future Conduct of Industry—Resolutions Presented by the Groups

THE Industrial Conference called some weeks ago by the President "for the purpose of reaching, if possible, some common ground of agreement and action with regard to the future conduct of industry" convened in Washington at the Pan American Union Building, Monday afternoon, Oct. 6. Owing to the illness of the President the Conference was called to order by Secretary of Labor Wilson, who acknowledged the courtesy of the Pan American Union in granting the use of the building for this occasion, and called upon John Barrett, Director General of the Pan American Union, for a brief address. Mr. Barrett's remarks were particularly appropriate, and calculated to throw an atmosphere of peace and harmony about the proceedings. Speaking of the Union as a practical league of 21 American nations, Mr. Barrett said that the deliberations of its board of governors had been the means of averting at least six potential wars among the member nations, while no conflict of any importance had occurred since the Union was established. Dedicated to the purposes of peace, the Union hoped that the Industrial Conference might be successful in finding a just and fair solution to its problems amid surroundings where many political issues had been amicably settled.

LABOR, THE PUBLIC AND EMPLOYERS REPRESENTED

The official delegates to the Conference comprised three groups, representing Labor, the Public and Employers. Labor delegates were seated on the left, Employers on the right, with representatives of the Public in the middle. Over 75 representatives of the daily and industrial press were present to report the proceedings.

After the President's official call was read there was a roll call of delegates representing respectively:

The Public: Bernard M. Baruch, Robert S. Brookings, John D. Rockefeller, Jr., Elbert H. Gary, Charles W. Eliot, John Spargo, O. E. Bradfute, Ward M. Burgess, Fuller E. Calloway, Thomas L. Chadbourne, H. B. Endicott, Paul L. Feiss, Henry S. Dennison, George R. James, Thomas D. Jones, A. A. Landon, E. T. Meredith, Gavin McNab, L. D. Sweet, Louis Titus, Charles Edward Russell, Bert M. Jewell.

Women: Lillian D. Wald, Gertrude Barnum, Ida M. Tarbell.

Chamber of Commerce of the U. S.: Harry A. Wheeler, Ernest T. Trigg, Herbert F. Perkins, John J. Raskob, Homer L. Ferguson.

Farmers' Organizations: J. N. Tittemore, T. C. Atkeson, C. S. Barrett.

Investment Bankers Association of America: Edgar L. Marston, Howard W. Fenton.

Organized Labor: Samuel Gompers, Frank Morrison, Daniel J. Tobin, Joseph F. Valentine, Frank Duffy, W. D. Mahon, T. A. Rickert, Jacob Fischer, Matthew Woll, John L. Lewis, Mrs. Sarah Conboy, William H. Johnston, Paul Scharrenberg, John H. Donlin, M. F. Tighe.

National Industrial Conference Board: Frederick P. Fish, J. W. O'Leary, S. Pemberton Hutchinson, Edwin Farnham Green, Leonor Fresnel Loree.

Railroad Brotherhoods: Engineers, H. E. Wills; Fireman, P. J. McNamara; Trainmen, W. G. Lee; Conductors, L. O. Sheppard.

Railroad Managers: R. H. Aishton, Carl R. Gray.

PURPOSES OF CONFERENCE EXPLAINED BY SECRETARY WILSON

Secretary Wilson then delivered a short address on the purposes of the Conference. First expressing regret that the President was unable to direct the Conference in person, the Secretary reviewed briefly the industrial conditions that had grown out of the war. The loss of life, the destruction of material resources, the derangement of industry, and the instability of governments have all contributed to the most difficult peace-time problem that has ever confronted the country.

"The effect of these things," he said, "has been reflected in the high cost of living and the consequent demand for higher wage rates to meet the increasing burden of the family budget. Yet increases in the wage rate do not always give relief. There are but two ways by which the general standard of living of the wage-workers can be improved. One is by increased productivity, making more material available for wages. The other is by taking the means of increased compensation out of the profits of the employer. If wages are increased and profits remain the same, the burden is passed on to the consuming public in the form of an increased cost of living, and comes back in that form to the wage-worker himself. No portion of improved standards of living can come out of the profits of the employers unless there is profiteering.

WHOLE WORLD INTERESTED IN PRODUCTION

"The whole world is interested in returning to the highest productive efficiency, having due regard to the health, safety, and opportunities for rest, recreation and improvement of those who toil. The most productive we are the sooner we will replace the wastage of war, return to normal price-levels, and abolish the opportunity for profiteering. There can be no profiteering where the production is ample to meet the needs of the people of the world if there is a free flow of material from producer to consumer. It is only where the production is not sufficient for the needs of the people, or, when sufficient, where artificial obstructions impede proper distribution that there is any possibility of profiteering. Anything that restricts the highest efficiency commensurate with the physical, mental and spiritual well-being of the workers tends to retard the progress of the country as a whole.

INDUSTRIAL JUSTICE THE BASIS OF INDUSTRIAL PEACE

"For that reason we are all interested in the maintenance of industrial peace, but there can be no permanent industrial peace that is not based upon industrial justice. Nor is it sufficient that either side to an industrial controversy should be the sole judge of what constitutes justice. The means must exist by which all men may know that justice has been secured. An imaginary wrong has all the force and effect of reality until it is shown that it is only imaginary. We have found ways of regulating all the other relations of mankind. Surely human intelligence can devise some acceptable method of adjusting the relationship between employer and employee.

"The right of any man to cease working for another for any reason that is sufficient to himself is the basic element of human liberty. The right of any person to refuse to operate his plant at any time he desires to do so is the exercise of a property right guaranteed by the Constitution. It does not follow that because these rights exist it is necessary to exercise them. They must nevertheless be safeguarded. Having done that and having devised the machinery by which justice can be secured and by which everybody at interest has the opportunity of knowing that justice has been secured, it is not likely that the right to cease work will be exercised by sufficient numbers, or the right to cease operating industrial plants will be carried to such an extent as to seriously affect the welfare of the balance of the people."

COMMITTEES APPOINTED

Following the Secretary's address, which was well received, he announced that the Conference would perfect its own organization and method of procedure. At his suggestion each of the three groups of delegates appointed two committees of three each, to constitute general committees (1) on organization and nominations and (2) on rules and order of business. The appointees were as follows:

On organization and nominations: Labor—Messrs. Morrison, Tobin and Sheppard. Employers—Messrs. Perkins, O'Leary and Marston. The Public—Messrs. Landon, Meredith and Brookings.

On rules and order of business: Labor—Messrs. Mahon, Woll and Lee. Employers—Messrs. Green, Wheeler and Atkeson. The Public—Messrs. Baruch, Chadbourne and Rockefeller.

The Conference then adjourned until Tuesday morning, Oct. 7, and the committees met immediately thereafter for the transaction of business

When the Conference again convened a permanent organization was effected with the Hon. Franklin K. Lane, Secretary of the Interior, as chairman, and J. J. Cotter and Lathrop Brown as secretaries. The selection of Mr. Lane as chairman was regarded by all as particularly happy on account of his recognized interest in the purposes of the Conference, his record for fairness and his private and public integrity. In his speech of acceptance Mr. Lane expressed confidence in the possibility of finding a solution for the problems to be considered. He approved of the Conference, which he said is the most important extra-legal body organized within our time. He also scouted the idea that social revolution would be necessary to accomplish the reforms in this country which have been sought by violent means in Russia and elsewhere, because, he said, our democracy had been achieved by a revolution that established our principle of government once for all. He considered the qualities of ignorance and arrogance to be the causes of unrest and dissatisfaction, and said that by the exercise of intelligence and tolerance we could be assured of some degree of success.

The committee on rules and order of business made its report, submitting a scheme of which the following were the salient points: Organization by groups for the consideration within the groups of any matters which members of the Conference may wish to bring before the entire body; assent required by each group before any proposal could be submitted to the Conference; a general committee of 15, five from each of the three groups, to which shall be submitted all proposals emanating from the groups; report by the general committee to the Conference, with or without recommendations; provision for minority reports; limitation of debate to 10 minutes; public sessions.

The General Committee was then constituted by group action, as follows:

Employers—Messrs. Hutchinson, O'Leary, Perkins, Raskob (secretary), Tittemore.

Employees—Messrs. Gompers, Morrison (secretary), Woll, Sheppard, Mahon.

The Public—Messrs. Chadbourne (chairman), Endicott, Landon, Russell, Miss Wald.

RULES OF PROCEDURE

When the Conference convened Wednesday morning, it was merely to announce the organization of the General Committee and a few additional rules of procedure. According to the rules adopted by the Conference, all proposals and programs must originate in one of the three groups, be referred automatically to the General Committee of 15 if assented to by the group, and then referred back to the Conference, with or without amendment, for debate. Under these conditions the Conference found itself on the third day of its convention without anything to do, but with approved machinery for doing anything that might be brought up. There was nothing to be done, therefore, but to adjourn the Conference until Thursday morning so that the groups might discuss proposals of their respective members and agree, if possible, on resolutions or programs for presentation to the General Committee.

When Secretary Lane adjourned the meeting for the day he wisely suggested that the delegates remain in the room for half an hour or more and get acquainted with each other. He thought the purposes of the Conference would be advanced if the representatives of the three groups knew one another personally.

RESOLUTIONS AND PROPOSALS PRESENTED

Following the rules, certain resolutions and proposals were offered by the three groups, representing Labor, the Public and the Employers; and while it is certain that other resolutions will be presented next week, and for that matter throughout the early weeks of the Conference, it may be worth while to examine those already offered and study their points of agreement and divergence.

The Public Group was the first to offer resolutions, and these were presented in the names of their respective authors with the "assent" of the group to their consideration by the Conference. This was strictly in accord with the agreed procedure, and it was made clear that the group did not necessarily approve of the proposals, but merely assented to their presentation as germane to the objects of the Conference.

Labor, on the other hand, when its turn came to offer proposals, brought forward a program in which the group concurred as a whole, thus presenting a united front. Mr. Gompers made it plain that the Labor group had acted as a body in formulating its program, and that there was "no pride of authorship" in any of the proposals. On the contrary, Labor had endeavored to enunciate a series of "principles and actions which they believed would contribute most to the purpose of the Conference as indicated in the President's letter." In this the four railroad Brotherhoods concurred, although doubt had been expressed as to whether they would ever enter the Conference.

When the Employers Group was called upon for its resolutions nothing was offered because of lack of time in which to formulate a prgram to which all would assent. Unlike the Labor Group, which represented a single element, strongly organized and united, the Employers were composed of delegates from widely separated industries, and more time was required to enunciate a set of principles. Later, however, the Employers brought forward one resolution by Mr. Loree and a "statement of principles which should govern the employment relation in industry." Both of these documents were of the highest importance, and the latter was especially broad, comprehensive and progressive.

During the discussion which ensued on the request of the Employers Group for more time, Dr. Eliot took occasion to comment on the purposes of the Conference and on the nature of the resolutions offered by Labor. Arguing that the Conference was called for the purpose of discovering *new* relations between capital and labor, he contended that the program offered by Labor was along old lines and contained only the old familiar contentions that had been the subject of endless dispute. "The fact is," he said, "that the speech just made by Mr. Gompers shows that Labor is here to contend within the Conference for what are called the rights of labor; and there have occurred many indications already that there is a large group of employers who are prepared to resist the methods of approach to business which we have heard proposed by the group of Labor. Among all the propositions that have been submitted to this Conference this morning there are several which relate, not to new relations between capital and labor, but to the old, to the former conditions of things in this country, in regard to industrial strikes, to the strengthening of the modes of combat with which our whole community has now become familiar. I venture to suggest that the Conference ought to make a new start if it is going to bring to pass any substantial results in creating new relations between capital and labor."

DISPOSAL OF RESOLUTIONS ORIGINATING OUTSIDE OF THE CONFERENCE

After the three groups had introduced their resolutions, Chairman Lane announced that numerous suggestions bearing on the work of the Conference had been received by him, and he asked what disposal should be made of them. This precipitated a debate in which the attitude of Mr. Gompers was misunderstood as being opposed to receiving outside suggestions. In his remarks on the subject he departed from the question long enough to pay his respects to the manner in which the Conference proceedings were being reported in the daily press, scoring particularly the inaccurate and unfair stories appearing in the Washington *Post*.

On the suggestion of Secretary of Labor Wilson, the Conference finally agreed to receive all suggestions offered from whatever source, prepare them in triplicate and submit them to the three groups of the Conference for consideration.

LABOR ASKS SETTLEMENT OF STEEL STRIKE

The first resolution introduced by the Labor Group was one calling upon the Conference to appoint two of its members from each group to constitute a committee to adjudicate and settle the differences between the workers and employers in the steel industry. There was a wide difference of opinion on the propriety of bringing this matter before the Conference, many feeling that the Conference was not called to settle individual disputes but to devise means for effecting settlements and if possible avoiding strikes and lockouts. There was ample evidence that the resolution might become the most contentious matter before the Conference and considerable doubt was expressed as to its adoption.

In addition to this resolution Labor presented a platform of principles declaring for collective bargaining; the eight-hour day; minimum living wage; equal pay for women performing equal work with men; prohibition of child labor; the establishment of industrial labor boards for conciliation and arbitration; and prohibition of immigration for a period of two years following the declaration of peace.

Similarly the Employers Group offered a set of principles on the following topics: Production; the establishment rather than the industry as a productive unit; conditions of work; wages; hours of work; settlement of disputes; right to associate; responsibility of associations; freedom of contract; the open shop; the right to strike or lock out; training.

CONFERENCE TO ACT IN INTEREST OF GENERAL PUBLIC

The first of the general resolutions to be introduced was that of Mr. F. P. Fish of the Employers Group, designed to commit the Conference to the principle of acting for the whole people—the consuming public—rather than in the interest of any one of the three groups represented in the Conference. The resolution declared that "the questions to be considered by this Conference are of vital importance to all the people of the United States individually and connectively"; that each and every citizen is interested in securing the benefits that would flow from harmonious relations between capital and labor; and that it is the duty of each delegate to feel that he is a representative of all the the people.

RESOLUTIONS ON COLLECTIVE BARGAINING

The other resolutions introduced during the first week of the Conference covered a wide range of subjects, but can be classified under a few headings. Collective bargaining came in for more attention than any other subject, being the basis of five resolutions. Mr. Dennison of the Public Group offered one suggesting that "employers and employees in every factory should unite in bringing about the development of committees freely elected by the employees (whether as a part of the trade union system or otherwise but not in antagonism to trade unionism) for the joint consideration of such constructive matters as methods of enlisting workers' interest and of improving efficiency of production, which are of mutual value to employers and employees." Another resolution of Mr. Dennison seeks to provide for equality of bargaining power by having (1) employers recognize the right of their employees independently to organize for the purpose of collective bargaining and to be ready to meet "any group of their employees either directly or through representatives"; and (2) labor recognize the right of employers to deal with their employees directly, "through freely elected shop committees or otherwise, as well as through trade unions."

The views of the Labor Group on this important subject were embodied in a part of their propositions. They declared in favor of "the right of wage-earners to organize in trade and labor unions for the protection and promotion of their rights, interests and welfare; the right of wage-earners to bargain collectively through trade and labor unions with employers regarding wages, hours of labor, and relations and conditions of employment; the right of wage-earners to be represented by representatives of their own choosing in negotiation and adjustments with employers with respect to wages, etc." Labor further declared for the "right of employers to organize into associations or groups to bargain collectively through their chosen representatives with respect to wages, etc."

Mr. Rockefeller's resolution on collective bargaining affirmed that inasmuch as the only common ground for agreement in industrial relations must be "the spirit of justice, brotherhood and willingness to put one's self in the other man's place," employees must have representation in industry which will give them an effective voice in determining their terms of employment and their working and living conditions. He believes that the particular form of representation is a question to be decided in each case, but that "adequate representation" shall include provision whereby stockholders and employees' representatives may give current consideration to matters of common interest. He also states that provision should be made "to insure the prompt uncovering of grievances, real or alleged, and their speedy adjustment."

On this same subject the Employers Group made the following declarations: "Each establishment should develop contact and full opportunity for interchange of view between management and men, through individual or collective dealing or a combination of both, or by some other effective method"; and further that "each establishment should provide adequate means for the discussion of all questions and the just and prompt settlement of all disputes that arise between management and men."

MEDIATION, CONCILIATION AND ARBITRATION

Related to the resolutions on collective bargaining, and of no less importance, were those on methods of conciliating the parties to industrial disputes and arbitrating their differences. These proposals embodied specific plans, and it is not unlikely that they will comprise the most important subject to be considered by the Conference.

Mr. McNab of the Public Group offered a resolution based on the premise that it is "the purpose of this conference to discover a method of removing the causes of industrial unrest and strife." He proposed legislation by Congress to create a National Board of Conciliation and Arbitration constituted as follows: Four members, at least one of whom shall be a woman, to be appointed by the President; two members to be appointed by the Senate and two by the House of Representatives; and the remainder to consist of the ex-Presidents of the United States and the Secretary of Labor. This board would be available for the settlement of all disputes between capital and labor, acting either as a board or through one of its members being a third party to a joint board of contending parties. A condition of arbitration by such board would be the resumption of normal relations during the hearing, and the findings would be retroactive to the date of the controversy.

Secretary Wilson's plan calls for the creation of boards of employers and employees in each principal industry and a similar board for miscellaneous industries. Representatives on these boards are to be selected as the employers and employees may respectively determine. Industrial disputes that cannot be adjusted locally are to be referred to the board created for that industry, the board to take jurisdiction whenever in the judgment of one-half of its members a strike or lockout is imminent. If the particular industrial board cannot adjudicate the matter it is to be referred to a general board to be appointed by the President as follows: One-third to be appointed in agreement with organizations representative of employers, one-third in agreement with organizations representative of labor, and one-third by the President direct. This general board must be unanimous in its decision on disputes submitted to it, and in event of failure to reach unanimity the question shall be submitted to an umpire selected by unanimous action of the general board or drawn by lot from a list of 20 persons named by the President to act as such umpires. Decisions, however reached, are to have the force and effect of trade agreements which both sides shall be morally bound to accept and abide by.

The Labor Group's proposal on this subject called for the establishment in each industry of a national conference board, "by agreement between the organized workers and associated employers, consisting of an equal number of representatives of workers and employers." This industrial board should consider subjects affecting the progress and welfare of the industry, promote efficiency of production and the rights of all concerned. Further, the Federal Government should be asked to act through the Department of Labor in encouraging the formation of industrial conference boards in the industries where they do not now exist.

RESOLUTIONS ON IMMIGRATION AND MISCELLANEOUS SUBJECTS

Other important proposals touched on such subjects as the high cost of living, hours of labor, wages, the employment of women and children, and immigration. Labor stood fast for the standard eight-hour day, while the Employers declared that hours "should be fixed at the point consistent with the health of the worker and his right to an adequate period of leisure for rest, recreation, home-life and self-development. The standard of the work schedule should be the week, varying as the peculiar requirements of the individual industries may demand." Both sides agreed on the necessity of one day of rest in seven; the payment of overtime at the rate of time and a half was mentioned by Labor.

On the subject of wages Labor demanded "a living wage which shall insure the workers and their families to live in health and comfort in accord with the concepts and standards of American life." The Employers, on the other hand, suggested that the determination of wages must take account of the efficiency of the worker, recognizing "the quantity and quality of his productive effort." They agreed to a minimum wage that should enable the worker to maintain himself and family at a standard of living satisfactory to a right-minded man in view of the prevailing cost of living. Bonus payments, profit-sharing and stock ownership were recommended for consideration. Equal pay for women doing the same work as men was approved by both sides.

Immigration was dealt with only by Labor, which asked that all immigration into the United States be prohibited at least until two years after the declaration of peace. It was further declared that the flow of immigration should at no time exceed the nation's ability to assimilate and Americanize the immigrants, and that immigration should always be prohibited when an abnormal condition of unemployment exists in the United States.

An effective method of dealing with the high cost of living was sought in a resolution by Mr. Russell of the Public Group calling upon Congress to pass an anti-profiteering act similar to that of Great Britain.

The shortest resolution offered was that of Mr. Fuller Calloway of the Employers, as follows: "Resolved that individual initiative and enterprise should be encouraged." Despite its brevity this resolution embodies a principle which is a matter of contention between workers and employers. It has been claimed that labor organizations tend too much toward standardization of the job and the individual and the output, without providing for or recognizing the necessity of offering incentives for greater effort or superior ability on the part of individuals. After offering his resolution Mr. Calloway spoke at some length on the system adopted in a cotton-mill community at La Grange, Ga., where various co-operative schemes have been in vogue between the employer and employees, including provision for education, health and hygiene, and recreation, as well as a scheme for profit-sharing.

REQUEST FOR CENSUS DATA

Of fundamental importance was a resolution by Mr. Loree of the Employers asking that Congress take necessary steps to secure information on our population, employed and unemployed, male and female; home and foreign income; wages, hours of labor, salaries and profits of the principal industries; surplus and depreciation; taxes, royalties, rents, interest, advertising; reserves necessary for the progress of an increasing population and the spendable income of management and capital. It was urged that full advantage be taken of the census of 1920 in securing much of this information.

The Employers' program was more comprehensive than that of the Labor Group and was considered also by many to be more progressive. It naturally gave more attention to the function of Management in industry than did the Labor program, for Labor regards Management as a side partner with Capital and not as an intermediary responsible to both Capital and Labor. The Employers also preferred to consider the individual establishment rather than the industry as the unit in which industrial relations should be fostered and improved. Where Labor contends for the unionization of an entire industry and the settlement of wages, hours of labor and conditions of employment throughout that industry, the Employers suggest that better results can be obtained by experimenting in the establishment. On the subject of wages, Labor wants all of the workers' reward to be paid as wages and not as additional compensation in the form of profit-sharing, bonuses and stock ownership.

On the subject of the open or closed shop the Labor Group made no proposition, but the Employers declared for the open shop "in which membership or non-membership in any association is not made a condition of employment." They also declared that "coercive methods aimed at turning the 'open shop' into a 'closed union' or 'closed non-union' shop should not be tolerated."

On the subject of strikes and lockouts the Employers again made a declaration without a corresponding one from the Labor Group being offered. The Employers distinguished sharply between employment in the field of private industry, in public service and in Government service. The nature of Government service and that of the utility corporations was regarded as sufficiently different from that of private industry to warrant the prohibition of strikes on the part of workers engaged in such work. "A strike of Government employees is an attempt to prevent the operation of government until the demands of such employees are granted, and cannot be tolerated." On the other hand, "the right of Government employees to be heard and to secure just redress should be amply safeguarded." The sympathetic strike was condemned, as was the blacklist, the boycott and the sympathetic lockout.

LABOR SEEKS ACTION ON STEEL STRIKE RESOLUTION

Adjournment of the Conference at the end of the first week of its deliberations came in a rather dramatic way and showed clearly that there was a deadlock, temporarily at least, on the issue of attempting to settle the steel strike. Various members of the Conference had previously addressed themselves to the proposition that the resolution was not germane to the purposes of the Conference, and stated that it should not be considered. The Committee of Fifteen, however, had to consider it, under the rules, and report it in some way or other to the Conference. The chairman of this committee reported on Friday afternoon, Oct. 10, that the steel strike resolution had occupied the attention of the committee for some hours and that no report of substance or merit could be expected without further work. An adjournment was moved until the following Tuesday morning. Mr. Gompers, however, was loath to see the resolution go over till the next week, and suggested a shorter adjournment, which was finally agreed to. It was quite evident that Labor was banking heavily on the action of the Conference on this resolution and wanted early action. Adjournment for one hour was then agreed to, but at the end of that time the General Committee reported in favor of adjournment until Tuesday, as in the first instance. It was apparent from this action, without further announcement, that the committee had been unable to agree on a report on the resolution to settle the steel strike, and the Conference was adjourned.

American Petroleum Institute

Plans whereby the American Petroleum Institute will spend at least $500,000 annually for research and statistical work practically have been completed. The proposed organization of the Division of Research and Statistics submitted by Dr. Van H. Manning, the director of the Bureau of Mines, has been approved and will be put into effect in the near future, it is understood.

The division is to be under the general supervision of a technical director. His chief assistants are to be an economist and an engineer. The economist, in addition to studying the economic phases of the industry, is to have charge of statistics. The engineer will be in charge of research. It is the intention to concentrate in the Institute all statistics regarding individual operations from which generalized statements can be made to the Government or for publication. The statistics will go deeply into the matter of prices of crude oil, refined products and natural gas. Economic studies are not to be confined to the United States but will extend to foreign countries. So that work may be thorough, agents will be located in important foreign commercial centers. Steps will be taken to bring about uniform cost accounting and uniform laws and regulations.

Under research the division will take up studies of production, chemical engineering, utilization, and work on special problems. In the matter of chemistry it is admitted that an almost unlimited field is presented, but at the start the work will be concentrated largely on the selection and correlating of chemical information pertaining to oil and natural gas. Among the problems which are to receive early attention are: Recovery of spent acid in refining gasoline and kerosene; development of more efficient distillation methods for very closely refined products and a more efficient recovery of uncondensed gases from the stills. Cracking processes also are to be studied with regard to chemical engineering and general economy.

The Dangers of the Postal-Zone Law

By Arthur Capper
U. S. Senator from Kansas

THERE is no subject of greater importance to the public than that involved in the postal principles on which is based our postal legislation. The present postal-zone law needs careful consideration, and every citizen and home throughout this nation should earnestly endeavor to understand the important factors involved.

For there is no function of government that reaches every citizen and every home to the extent of our United States postal service. For over seventy years the history of our postal legislation shows that our country has not legislated for postal service on the basis of cost, because the postal service is of such universal benefit, is such an instrument of information and education and unification, that to restrict it in any way is to hurt the country that we as thinking citizens wish to serve. So clearly and firmly has this American postal principle been held, that postage cost must not determine the postage rate, that our post office has delivered letters and publications to Yankee whaling ships at Point Barrow in the Arctic Circle for two cents that cost over $5.60 to deliver. I would ask any thinking citizen if it is not just as important that a Yankee skipper home from a whaling cruise shall be able to understand and vote intelligently upon the great public questions of the day as it is for the citizen who has stayed at home? This principle is sound. Shall not California, Kansas and Maine have equal postage on all information as an American right?

Our rural free delivery system—the most expensive and least revenue-producing branch of the post office—costs 1½ cents per piece of mail matter, and this 1½ cents is over and above the cost of collecting, sorting, handling, transporting and rehandling until it gets into the rural free delivery carrier's wagon. This has all been done upon the American postal theory that the post office function was a service to the American people and that the cheapness of postage was a benefit to the American home.

It has been alleged—and maybe some have fallen victim to its un-American and illogical absurdity—that cheap postage on magazines and newspapers is a subsidy to the publishers. It is not a subsidy to the publishers. It is, if you want to use the term "subsidy," a subsidy to American readers. You can determine this for yourself. Who receives the benefit or subsidy when the Yankee skipper of a whaling ship off Point Barrow, in the Arctic Circle, receives news from home which costs $5.60 to deliver? Is that a subsidy to his home newspaper, his periodical or magazine, or is the benefit of that to the ship captain himself and his citizenship and our united and national standards of intelligence?

You will instantly recognize that it is this ship captain receiver of costly postal service who is benefited, and your common sense will instantly prove to you that in every case of cheap postage the primary and entire benefit is to the receiver. Would you have Kansas pay higher postage than New York merely because any information happened to be printed in New York? Why handicap the postal service of Kansas by a higher and discriminatory postage rate? I come from Kansas, but the discrimination is similarly true of every other State.

Cheap postage on periodicals and newspapers has made the American nation a nation of readers beyond any nation in the world. If there is any thought in your mind that *this* is *not* a national benefit, I ask you to compare in your mind this great country with its splendid and homogeneous American idealism, its singleness of purpose and the universality of its achievements with those nations in the world in which there is but little magazine reading.

Now as a practical proposition. You know the economic law that all costs must ultimately be paid by the final consumer, i.e., in this case the reader. To raise the postage on publications means that the publishers, as business men, must add this charge to the price of their periodicals—and thus lessen reading. Is this a good thing? And again I ask every reader to consider those nations in the world which have never encouraged widespread reading nor the widespread distribution of periodicals and newspapers, and to answer that question.

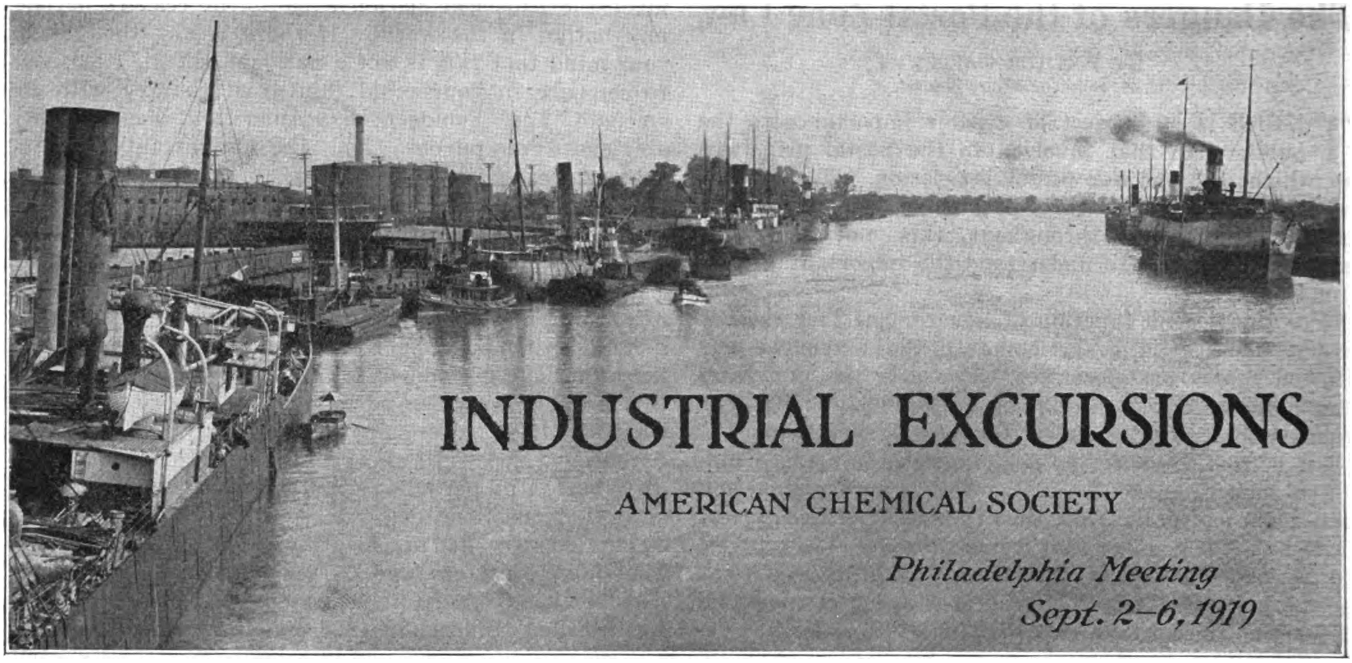
This country had a postal-zone system at one time, applying to letters and newspapers and periodicals. The abolition of the zone system was made complete by President Lincoln in 1863 and the zone system was abolished not only on periodicals and newspapers, but also on letters, because it was regarded as an unsound postal policy and un-American that a citizen or home should have to pay more postage simply by an accidentally greater distance from the point of mailing.

Now on the practical side I wish to point out that the country newspapers have circulation in their county of publication without any postage charge whatsoever and this can only be justified and continued on our American theory that the postal function is an equal service to all American homes.

It would be obviously unfair for those supporting the postal theory that the cost must determine the rate of postage to ask that a letter costing 1½ cents for delivery alone on rural routes should be sent for one cent. I do not have to be convinced that we should have one cent letter postage. I am for cheap postage as a great American social service. I believe that every right-thinking American is for cheap and equal postage. But there is no logical reason for believing that the rate on one class of postal matter must be determined by the rate on another class of postal matter. The figures of postal cost upon which this unsound and un-American postal cost theory is demanded were compiled in 1907 and upon being investigated by the United States Postal Commission headed by the Hon. Charles E. Hughes, these figures were discarded as utterly unreliable in determining the cost of handling newspapers and periodicals. Yet it is upon these discarded cost figures that such unsound arguments are based.

If we must abolish postal service—or increase postage rates to a prohibitive basis—on the theory that cost of service shall determine the postage rates, we should have to abandon many of the most important of our postal functions, the rural free delivery being the most conspicuous example and one which I believe should be kept up no matter what its cost, as it is the most important postal service in the entire department. It pays too high a return—as does every other postal service—in improved and elevated citizenship.

I earnestly hope that every reader will give this postal-zone matter and its revival of unsound postal theories that have been discredited for over two generations very serious thought.



INDUSTRIAL EXCURSIONS

AMERICAN CHEMICAL SOCIETY

Philadelphia Meeting
Sept. 2–6, 1919

SEVENTEEN of the representative plants of Philadelphia acted as hosts on the afternoon of Sept. 4 to the members attending the fifty-eighth meeting of the American Chemical Society. Thus a choice was given of seeing one of the elite of the following industries: petroleum, leather, storage batteries, lime, coal-tar products, rare earths, paper,[1] printing, gas, paint, rubber, sugar, phonographs, antitoxins and water. Many of these proved to be of exceptional interest and are therefore included in this continuation of the erport of the meeting.

The Atlantic Refining Co.

The works of the Atlantic Refining Co. occupy an area of one square mile, or nearly 1 per cent of the city-county of Philadelphia. Two hundred and fifty-odd stills equipped with condensers and varying in capacity from 600 to 1250 bbl. make up the actual equipment inventory along with 4000 tanks holding up to 55,000 bbl., 825 automobile trucks, seven 11,000-ton tank steamers, hundreds of miles of pipe lines and pumps to correspond. Eleven thousand employees seem to be a small force with which to operate such an enormous works, but everything is done mechanically, with a minimum expenditure of man power. The present equipment capacity is about 45,000 bbl. of crude oil per day, which is received through 8-in. and 6-in. pipes from the various Pennsylvania, West Virginia and Mid-continental oil fields. Various grades of crude are shot through the same line one after the other without having as much tendency to get mixed up as is often exhibited on our rail transit lines. Schedules are made and kept. The arrival of the new crude supply means the quick shifting of a few valves to place it in the right tank, as its analysis has been wired in from its point of shipment and a tank has been provided.

REFINERY PRACTICE

There is considerable variety in the practice of petroleum distillation, owing principally to the variations in the crude oils and the specifications of the two hundred-odd products made.

The following is an elementary outline taken on an average of the progressive distillation and treatment of oil. It must be noted at the start that the composition of an oil vapor is dependent on the partial pressures of all the constituents, which in turn are dependent on their vapor pressure and concentration in the liquid. For this reason the first distillate, called crude benzine, has a little of the whole paraffine series. However, a fractional condensation is made which segregates fairly well the gasoline hydrocarbons from pentane to nonane; the naphtha, from decane to tridecane; and the kerosene, on up to octadecane, etc. Of course all fractions are controlled at the gravity testing house, where hourly Baumé records are kept and the oil piped to the right tank. The speed of the vapor is very great at times, for often 50 bbl. of oil is taken off of a still per hour. For this reason some tarry matter is trained over, which is removed together with unsaturated hydrocarbons by agitating with 66 deg. oil of vitriol in a large vertical lead-lined tank built along the design of a separating funnel. After the acid sludge is drawn off, the oil is neutralized with caustic soda solution, washed with water and steamed.

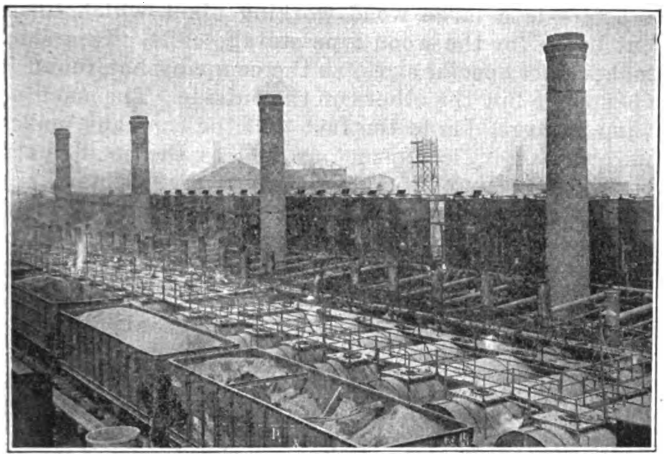
If the petroleum is a paraffine base, lubricating stock and the waxes begin to come over as soon as the light oils have stopped and the temperature of the still raised. It should be noted that practically all the stills are heated with fuel oil steam jets except in the latest installations, where fine coal screenings are fired with stokers. No arches are used with this type of heating. At first some trouble was found in the combustion gases from the fuel oil condensing on the cold still, but by lowering the fire zone this was overcome.

Evidence that the ordinary distillation process is not one of mere physical separation is found in the fact that if the paraffine residue is chilled, an amorphous non-crystalline solid segregates which is separated and refined under the name petrolatum, vaseline, etc. If this same fraction had been distilled, and the distillate chilled, hard paraffine wax would be the result.

Wax tailings are the last paraffine fraction, leaving coke in the still. Petroleum coke is one of the purest forms of carbon, and is used in making carbon elec-

---

[1] Dill & Collins Paper Mills, pp. 370-375, Sept. 15.



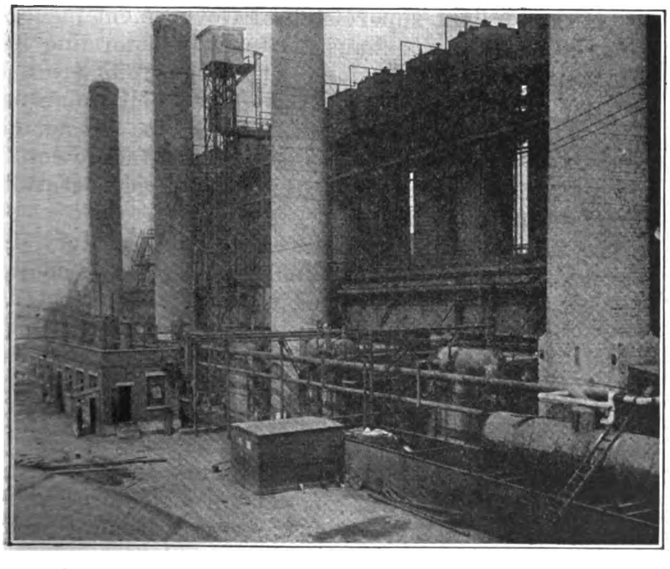
HIGH PRESSURE HORIZONTAL BURTON PROCESS STILLS

trodes. Being free from silica and low in sulphur, it makes an ideal reducer for such metals as aluminum, magnesium, etc., in the electrolytic reduction processes.

Of recent years the Mexican asphalt base crudes have been playing an ever increasingly important role. The light top fractions are taken off in a similar manner to the paraffine crude. The topped residue may be distilled up to 700 deg. F. and sold for fuel oil. If flux oil is desired, the residue is blown with air to dehydrogenate and polymerize the oil hydrocarbons into asphalt. If the air is applied for a sufficient period, the highest grades of asphalt may be produced of any desired melting point or penetration.

THE BURTON PROCESS

Many unsuccessful destructive distillation inventions have left their only trace in the files of the Patent Office, thus giving evidence that they grew to be no bigger than an original idea. James Young, Benton, and Dewar & Redwood, all have their supporters as being the real inventors of the destructive distillation of oil, though it is perfectly well known that they could not work the process commercially on account of their lack of equipment facilities. While the original Burton process was eventually operated successfully, it fell to the part of Clark, Hopkins and Humphreys to furnish several much needed improvements. A view of the battery of old horizontal direct-heated stills is given.

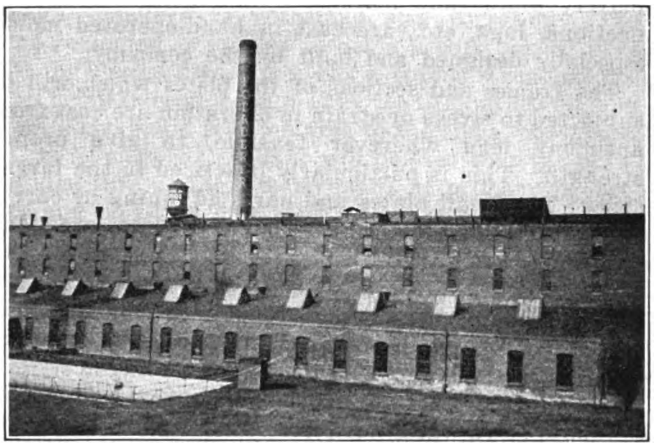


HIGH PRESSURE VERTICAL BURTON PROCESS STILLS

Coke deposit formation, with resulting overheating of the still in spots, made it necessary to drop the pressure of the vapors lower than desirable. Clark evolved the vertical boiler tube heater in conjunction with the tall vertical still towers. Boiler tube cleaners are used to cut out the coke layers at the beginning of each run, and in this way a pressure of 100 lb. can readily be obtained, with a corresponding high yield of cracked gasoline. The gases obtained are stored in regular gas holders and used for fuel within the works.

Robert H. Foerderer

At the plant of Robert H. Foerderer, the manufacture of vici kid was observed in the factory which grew to gigantic dimensions during 17 years of patent monopoly and well deserved popularity. Dry salted goat hides in bales of 500 are received, principally from Arabia, India and China. These are sorted, washed, soaked in water to soften and defleshed with scrapers. The hair is removed by leaving the hides several days in vats of old depilating lime liquor, which has become well inoculated with bacteria. The latter act on the embedding skin cells around the hair roots in such manner that when the hide is immersed in fresh lime solution for several days, ammonia is formed, the hides float up and the hair roots become disengaged. After passing the hides through rollers mounted with spiral scrapers to remove all the hair, they are delimed by soaking several days in oropon solution (ammonium chloride and dry hog pancreas). The soluble salts are then washed out, leaving a very porous skin structure saturated with neutral wash water. The hair obtained is graded, the different qualities being used in weaving rugs and carpets, making harness pads and reinforcing plaster.



"THE HOME OF VICI KID"

The two-bath chrome process used for tanning the skins consists of soaking the skins for several hours in a solution of sodium bichromate and muriatic acid in the proportion of 6 and 3 lb. each per hundred of skins. The reaction is:

$$Na_2Cr_2O_7 + 2HCl = 2NaCl + 2CrO_3 + H_2O$$

After the skins have become well yellowed with chromic oxide all the way through, they are greened by soaking in a reducing solution of hypo. This reaction is in three stages:

$$2CrO_3 + 6HCl + 3Na_2S_2O_3 = 3Na_2SO_4 + 3S + Cr_2Cl_6 + 3H_2O$$

$$Cr_2Cl_6 + Na_2S_2O_3 + H_2O = Cr_2(OH)_2Cl_4 + SO_2 + S + 2NaCl$$

The basic chloride is then converted to $Cr_2(OH)_6$ by washing in sodium bicarbonate.

The skins are now dyed, fat-liquored, dressed and glazed, finally being measured in an ingenious segment roller machine, inspected, graded and shipped.

The coated leather department was not visited, though fine specimens of this modern type of leather were exhibited at the office of the company.

The Electric Storage Battery Co.

The plant located at Nineteenth and Allegheny Sts., Philadelphia, is said to be one of the largest of its kind in operation today. The raw materials consist chiefly of pure lead, antimony lead in pigs, sulphuric acid, litharge, red lead, lumber and packing materials. Finished products such as glass jars for small batteries and rubber jars in all sizes are purchased from other manufacturers.

The visitor is immediately impressed with the extent of the lead-working activities, which embrace the larger part of the manufacturing establishment. All battery plates and fittings, terminals, busbars, connections, lugs, etc., are cast in hand-operated molds especially designed and built by the company.

The frames and sections of the plates which will be subjected to stress or strain in operation are cast from antimony lead wherever feasible, to give proper strength. This is particularly practiced in the larger sizes. The small plates and parts adjoining or carrying the activated material in the large plates are made from pure commercial lead, which is later burned to the antimony lead supports in assembling.

A noteworthy item in connection with the lead burning is the type of flame used. It was found unnecessary to employ the intense heat of the oxy-acetylene flame in this work, and the company therefore installed its own water gas plant. Water gas and oxygen are ignited in the torches. Other chemical plants having a considerable amount of lead burning to do might effect a saving through this feature.

There are two general types of grids made: The pasted grid, made up with a sort of mesh into which the red lead is plastered by hand to form a smooth surface, and the button or Manchester grid, which consists of an antimony lead plate punched with holes about ¾ in. in diameter. These holes then receive a button or roll of pure lead corrugated ribbon forced into place by hydraulic presses. This ribbon is made by extruding lead from the cold ingot at a pressure of 300 tons, resulting in a dense product. Large rolls similar to those employed in steel mills make the sheet lead from the pig for use as battery box linings.

The department for the making of wood separators used between plates covers considerable space and consists mainly of chemical processes. Cypress, cedar or California redwood is used and is first placed in a bath of hot alkali for several hours. From this it is taken through tanks involving about 20 operations which were not revealed to the visitors. The purpose of the process is to make the wood resistant to deterioration in the sulphuric acid bath of the battery.

The pasting of red lead on the grids is carried on by hand with a large number of workmen. The material is damp so there is little dust to cause lead poisoning. The men are required to have special suits of clothes furnished by the company and are forced to take at least one shower bath each week.

There is a large wood working plant which turns out boxes for the wood type storage cells. This shop makes only special sizes, as the company has found it cheaper to buy the others on the outside. The machine shop is large, due to the fact that the company makes its own factory equipment as well as the small metal parts, other than lead, for the battery outfits. The steel and copper parts are lead plated before assembling.

A variety of operations are carried on in the assembling departments. The individual plates are gathered in small racks where the busbars connecting a set for each cell are put on by the lead burners. The busbars are cast in hand molds in the same department. The sets thus formed are placed in the boxes which have been previously constructed and painted with asphaltum paint, in case of wooden containers, and the covers put on. The mechanical part of the cell thus completed is taken to the charging or activating department.

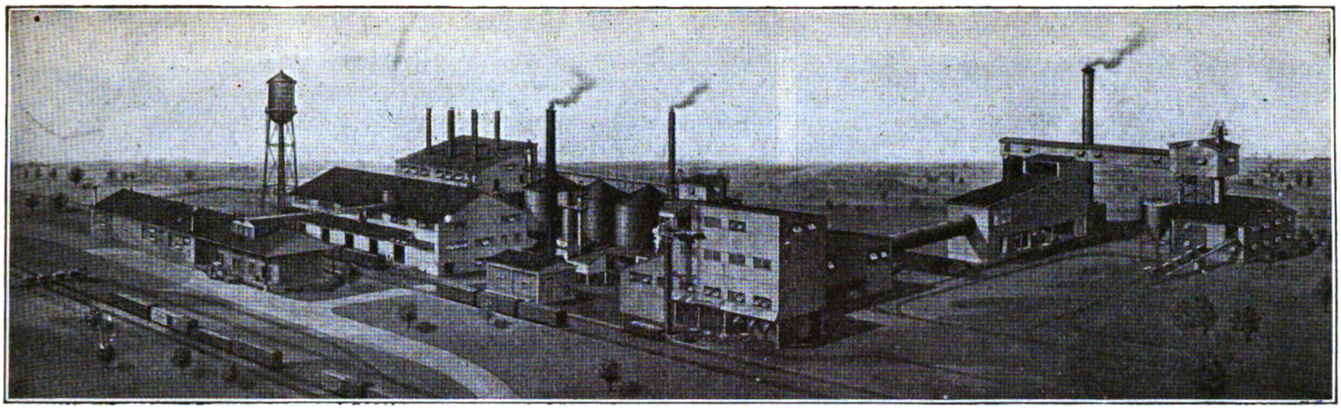
Several large rooms are in continuous operation where the acid is placed in the cell and the charging is carried on. Other large batteries of tanks are subjected to current for activating unassembled plates. The current for this work is supplied from a 2000-kw. steam-power plant supplemented by three substations receiving an additional 2500 kw. in power from the Philadelphia Electric Co.

The visitors witnessed the complete process of manufacture of several types of storage cells. One of these was the lighting set made for the Cadillac automobile, said to be one of the best turned out by the company. Another was a glass jar, 16 cell, farm lighting set built with the view of being assembled and put in operation by the layman. This set contains a pilot cell with a depression molded in the glass side about an inch in width and extending vertically along a part of the height. When the battery is in operation a composition ball of proper specific gravity floats in this slot, forming a hydrometer. When the ball is near the bottom of the slot the operator knows it is time to start his generator and when near the top the completion of the charge is thereby indicated.

The cell most worthy of mention, however, is that manufactured for submarine boat propulsion in the U. S. Navy. This cell is made with extreme care under the vigilant supervision of Government inspectors, who carry on exhaustive tests to determine its performance on completion. The large units are assembled in rubber jars, the completed cell weighing 2200 lb. Each battery for the new S type submarine is made up of 120 of these cells arranged in two equal groups for either independent or combined operation in propelling the boat.

The laboratories include a chemical laboratory, in which all raw materials are analyzed; a process laboratory, in which manufacturing methods are perfected; a research laboratory, for development work; a commercial laboratory, in which batteries are tested to determine their characteristics and life, and an engineering laboratory, in which auxiliary apparatus is developed and tested.

A thorough study of the work done in this plant would be well worth the time of anyone interested in either mechanical operations or electrochemical work relating to the operation of the storage battery.



HYDRATING AND ROTARY LIMEKILN WORKS

Cedar Hollow Limekilns

Three types of limekilns are operated in the Cedar Hollow plant of the Charles Warner Co. at Devault, Pa., the visit to which proved to be very instructive as well as a delightful excursion of 30 miles up the Chester Valley. For the benefit of those who think of the burning of limestone in the simplified symbols of $CaCO_3$ less CO_2 produces CaO with a little thermo and equilibrium chemistry thrown in, these few notes are designed to furnish somewhat of an appendix to their knowledge.

The decarbonating process of the dolomitic limestones begins as low as 660 deg. F. After all the CO_2 has been removed, which is around 2100 deg., the lime begins to harden. Only about 1½ per cent of acid fluxes (SiO_2, R_2O_3) are present in the raw stone, which reduces the tendency to sinter, but the lime structure apparently changes, becoming less porous, at a rate increase proportional to the magnesia content. The stone at the Cedar Hollow quarry is dolomitic, the ratio of lime (CaO) to magnesia (MgO) being very close to 3 to 2. This is very important in connection with the slaking properties of the product. Pure calcium oxide, as is well known, has to be added to its slaking water, because it is so porous, and thus reactive, that it will "burn" itself with the heat of reaction of the hydration. Probably this so-called "burned slaked lime" is a lower hydrate; at any rate, it is non-plastic, gritty, and cannot be used for plaster.

On the other hand, a dolomitic burned lime, being of a denser structure, can safely be slaked by adding water to it. This is a very desirable feature in the building trade, as it makes it easier to regulate the consistency and quality of the lime paste.

However, another peculiarity should be noted, and that is that if hard burned dolomite is added to a large bulk of water, the slaking reaction is very slow, because sufficient heat is not spontaneously generated to give the temperature required for the high-velocity reaction throughout the mass. Variations in the degree of burning, soft, medium and hard burned, depend on the period of firing, and, in turn, the size of the rock and the type of kiln.

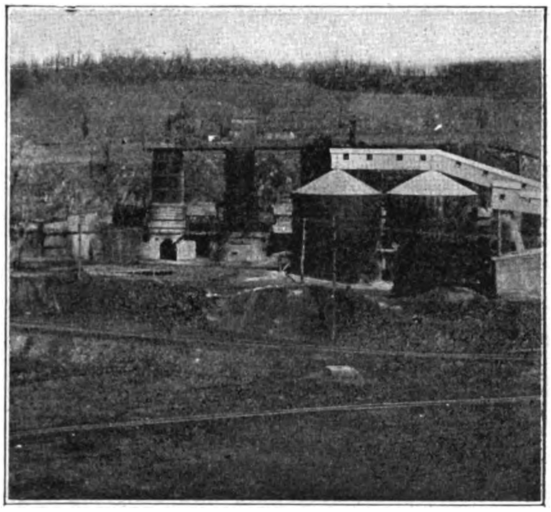
The terms dead, hard, medium, and soft burned, as applied to calcined dolomite and magnesite products, are primarily descriptive from a chemical activity point of view. Neither pure CaO nor MgO is fusible at atmospheric pressure, for their boiling points are below their melting points. However, on the same physical principle as exhibited in the case of alloys, etc., their melting points, or better, softening and cohering temperatures, are lowered by the association with foreign materials. In the case of magnesite, it has been found necessary to have several per cent of ferric oxide present to produce a dead burned refractory of dense enough structure to withstand slag corrosion. The same reasoning is applied in using a soft burned pure CaO for fluxing ores, for it has a porous structure, the pores being the space occupied by the CO_2 burned off, and offers a maximum reaction area to the silica, phosphate, etc., to be slagged. Thus it will be seen that the physical structure of these materials is of primary importance and that it is dependent on the chemical constitution together with the heat treatment given.

CEDAR HOLLOW QUARRY

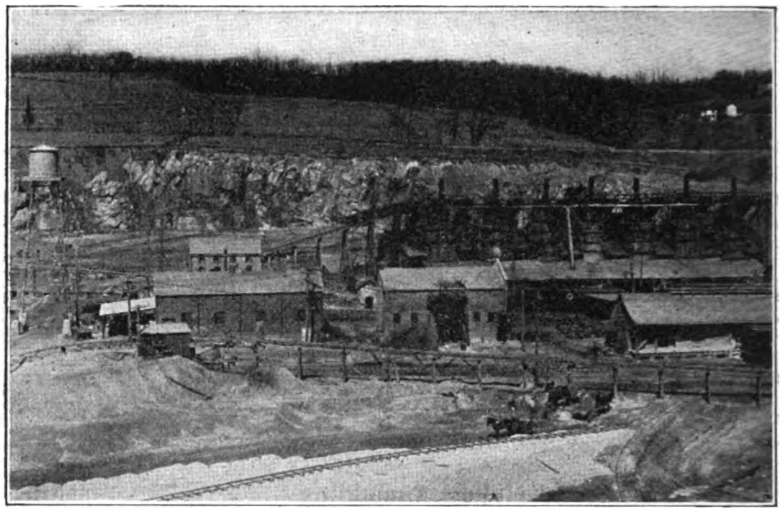
The quarry has been worked on a 40-ft. face over an area of about 25 acres. Recently a drainage tunnel about 800 ft. long was cut in so as to carry off the water from the second level, which will be 50 ft. lower than the floor of the original quarry. Better quarrying conditions cannot be conceived, as a floor of several million tons of virgin rock has been stripped of overburden and drained of surface water at what might be called a cost too negligible to take into account.

In the run-of-quarry blasted rock, all gradations of sizes are produced. Stone for lump lime, known as "one-man stone," i.e., pieces that can conveniently

QUARRY AFTER A BLAST



15-TON KILNS AND STORAGE TANKS



BATTERY OF SEVEN 10-TON VERTICAL KILNS

be handled by one man, are hand picked in the quarry and loaded upon quarry cars for transportation to the kilns. For best results in burning, a kiln charge must be fairly uniformly sized so as not to get too hard a burn with smaller pieces and at the same time leave no carbonate centers in the larger ones. The large rocks are broken up into "one-man stones" and graded to size.

The smaller pieces of stone, known as spalls, are crushed in a gyratory to pass a ¾-in. mesh screen. The material running less than ⅜ in. goes to the pulverized stone plant, where it is dried in a direct-fired rotary drier, pulverized in a Fuller-Lehigh mill and bagged through automatic packers. Over 85 per cent will pass 100 mesh. The pulverized stone is used in agriculture to counteract soil acids and to increase the porosity of heavy clay land. Of recent years great amounts have been used in filling tar and asphalt pavements. The ¾-in. stone is burned in a rotary kiln and slaked at the hydrating plant.

TYPES OF KILNS

The present equipment consists of seven 10-ton vertical brick, two 25-ton vertical brick, seven 15-ton steel jacketed kilns with direct coal firing, also one 50-ton vertical steel jacketed, and one 100-ton rotary kiln, each fired with producer gas. A vertical Mount kiln with rotating base is now in the course of erection, which is expected to increase the output 100 tons per 24 hr. of firing, thus giving a daily production of about 450 tons per day of burned lime.

The rotary kiln is used to burn the smaller sizes of stone, making the conversion in 2½ hr. Due to the short time of firing, the product is very soft and slakes quite rapidly, not having had time for the magnesia-lime condensation reaction referred to previously. It is pulverized and then slaked in a machine which proportions the correct amount of powdered lime and water conditions most favorable to give a high quality of product—called by the trade name of "Limoid."

Surplus burned lime product from the vertical kilns is mixed with the rotary product and the resulting mixture is used in making "Limoid" (hydrated lime). All Warner hydrated lime is seasoned in steel tanks for at least three days before finishing and shipping.

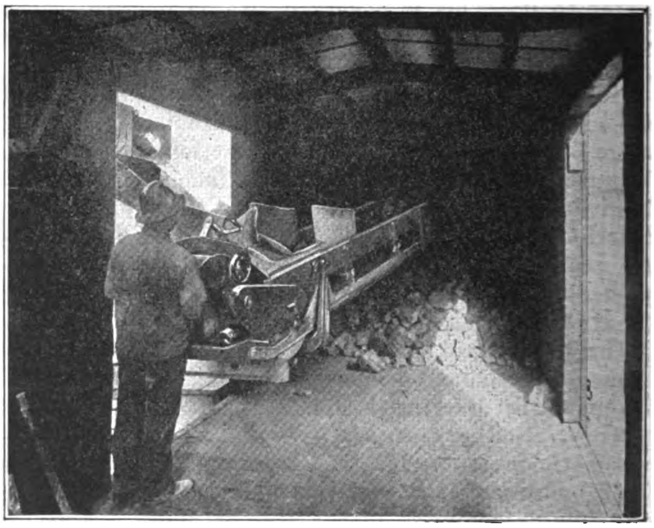
To produce a super quality of hydrate, the burned lime is specially hydrated and then finished in an air pulverizer, so that there are no tailings in the finished material. This is called "Kreme-Kote" and is used for high grade finishing plaster.

The vertical kilns are used for making lump lime and require from 24 to 72 hr. for conversion to medium burned lime having easily regulated slaking properties. The trade preference in some localities for lump lime was established in the days when the stone was burned directly with wood and coal fuel. Ancient practice was to sort out all the clean lumps, and sell the smaller pieces along with the fuel ashes for fertilizer. However, as a rule, small sizes usually indicated overburning with corresponding slaking trouble on the job and the trade now refuses to take time to investigate by running any slaking tests.

As long as there is an appreciable core of unburned stone, lumps in the kiln show dark spots against the incandescent mass. On cooling, lumps containing "core" (center of undecomposed stone) show a pink or salmon pink tint on the surface. Experienced lime men can make an infallible separation between properly burned and incompletely burned lime by this color test. This color test is applicable only to dolomitic lime.

COAL CONSUMPTION

Vertical kilns are the more economical in fuel costs, giving from 4 to 5 tons of lime to the ton of coal, as compared with 3 to 3½ tons with the rotary, in spite



MANIERRE BOX CAR LOADER

of the difference in the length of time of heating. Of course the greater production of the latter in proportion to the overhead costs counteracts the difference in fuel cost considerably. However, the Mount kiln should have the heating advantages of the stationary producer gas fired vertical and the controlled feeding of the rotary kiln. Forced firing and fast lime burning go hand in hand, but exit gases over 400 deg. indicate an uneconomical heat leakage, unless greater production must be had because of market activity.

Large steel tanks having a combined storage capacity of several thousand tons act not only as an inter-department regulator but as a seasonal reservoir. The plant is excellently equipped with conveyors, dump cars and machine car loaders. Fluctuations in shipping from none to 30 cars per day are thus readily provided for. A view is given of the first Manierre box car loader, installed in 1913, at work. The loader itself is an ingenious but simple belt conveyor, so carefully balanced on ball-bearings that one man can easily project it through the car door and into place. The end of the conveyor is raised or lowered so that the first lime charged into the car is deposited easily on the car floor with a minimum of breakage. As the pile builds up, the end of the conveyor is raised so that the drop of the lime is always a minimum.

The Barrett Company

The Frankford, Philadelphia, Works of the chemical department of the Barrett Company has grown out of the business originally started in 1884 by Dr. H. W. Jayne. In 1886 Dr. Jayne formed the partnership of Jayne & Chase, manufacturers of fine chemicals.

In 1887 the H. W. Jayne Chemical Co. was incorporated, specializing in refined coal-tar products such as naphthalene, carbolic acid, benzol and nitrobenzol.

In 1896 the H. W. Jayne Chemical Co. was one of the companies which formed the Barrett Manufacturing Co. Dr. Jayne was appointed manager of the Frankford plant, and held that position until his death, in 1910. The business in refined products from coal-tar has grown steadily along the lines originally laid down by Dr. Jayne. Many of the processes in use at the present time were worked out by him.

The plant has grown from a very small one, covering about three acres, to the present works, covering 17 acres.

An extensive research laboratory is maintained for the development of new products and the perfection of old processes. Practically the entire plant has been rebuilt during the last four years. To-day, with its up-to-date power plant, fire-fighting equipment, service buildings, dispensary, shops, etc., it is representative of the most modern type of chemical works.

The Frankford Works is essentially a refining plant and does not handle any crude-tar distillation. One of the principal processes is fractional distillation, the plant having an equipment of 35 column stills, varying in capacity from 1200 to 10,000 gallons.

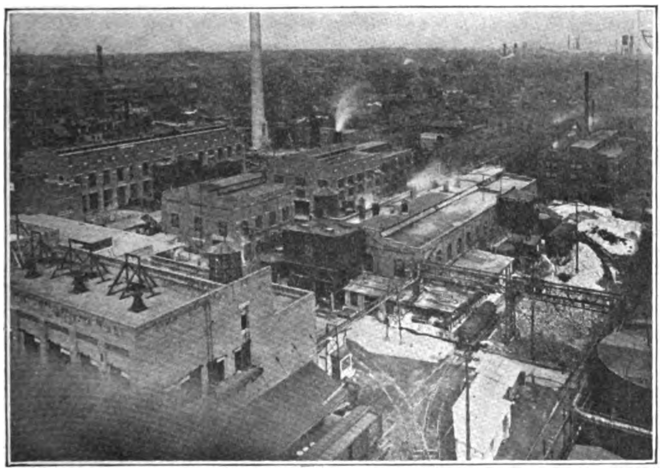
In the distillation of coal tar several fractions are cut, the actual operation being somewhat different for different plants. In general the first cut obtained is known as light oil and contains all of the benzol, toluol and xylol in the tar and some of the tar acids, pyridine bases and naphthalene. The second fraction, or carbolic oil, contains almost all of the naphthalene and tar acids and the bulk of the pyridine bases. The naphthalene is sometimes allowed to crystallize out of this oil and separated by centrifuging as a crude naphthalene. The tar acids are also sometimes extracted with caustic soda and the carbolate so formed decomposed with carbon dioxide, giving crude carbolic acid. The fraction following the carbolic oil is known as creosote oil and is used largely for creosoting purposes. A fourth fraction, known as anthracene or heavy oil, is sometimes taken off, this fraction on cooling crystallizing out a crude anthracene.

The chemical department of the Barrett Company takes as its crudes, light oil and carbolic oil from other plants, crude naphthalene and crude carbolic acids already removed from the carbolic oil and crude anthracene obtained from the heavy oil. In addition to this there are worked up several miscellaneous oils from outside sources, such as drip oils from gas works, coke oven light oils, etc.

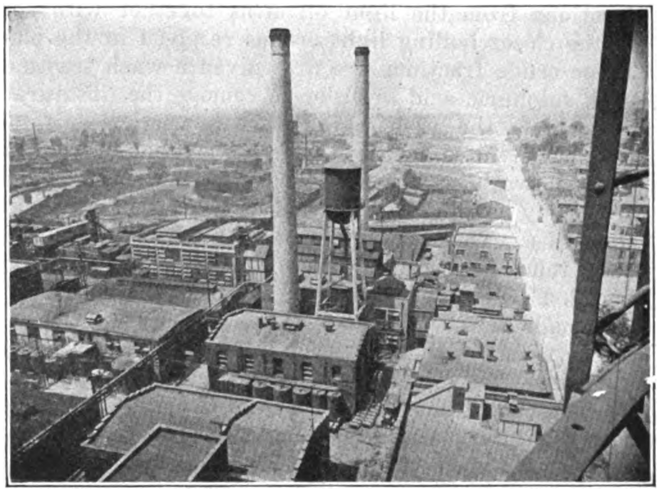
The following discussion attempts to take up the processes as carried out in the various buildings in as nearly as possible the order in which they take place.

LIGHT OIL FRACTIONS

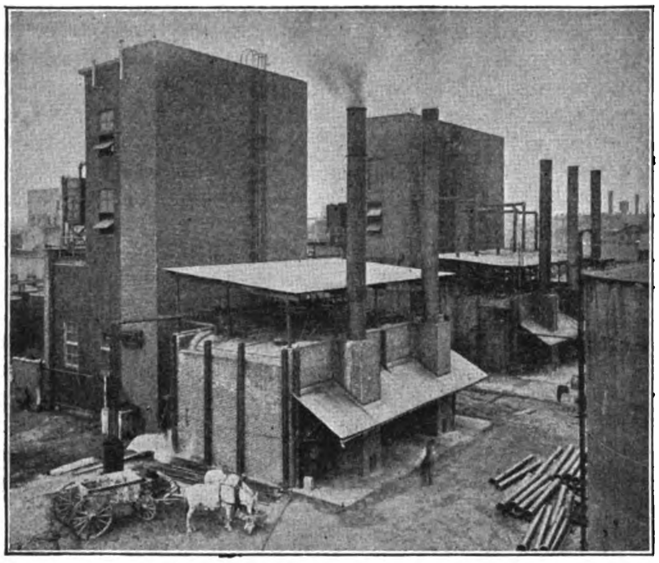
The light oil department consists of a battery of fire-heated fractionating stills equipped to run under vacuum, the fractionating columns being according to Barrett design, but following the general construction



Ordnance Phenol Naphthylamine Anthracene
Xylol Benzolsulphate Syn. Phenol
Benzol



Naphthalene Stills, Pan House Garage
Packing Power Administration
Crude Carbolic Machine Shops Laboratory



LIGHT-OIL FRACTIONATING STILLS

of containing a number of plates, each plate being provided with a considerable number of cone and bell arrangements, so that the upcoming vapor passes up through the cone and must bubble down underneath the bell through a layer of liquid on the plate. The plates are kept washed down continually by a flow of liquid condensate fed from a partial condenser or dephlegmator situated above the top of the column. The light oil stills form a starting point for the cruder oils received, light oil, carbolic oil, drip oil, etc., being distilled here. The plant produces crude benzol, crude toluol, crude solvent naphtha, which are further worked up elsewhere, and also a fraction from carbolic oil containing nearly all the tar acids and naphthalene. The residue from the stills is a tarry liquid and is accumulated and burned as fuel under the stills.

The distilled oils from the light-oil stills containing naphthalene are collected and allowed to cool in large shallow pans. Here the bulk of the naphthalene separates out and is separated from the oil by draining and centrifuging. The naphthalene so produced is crude naphthalene and is worked up at a later stage.

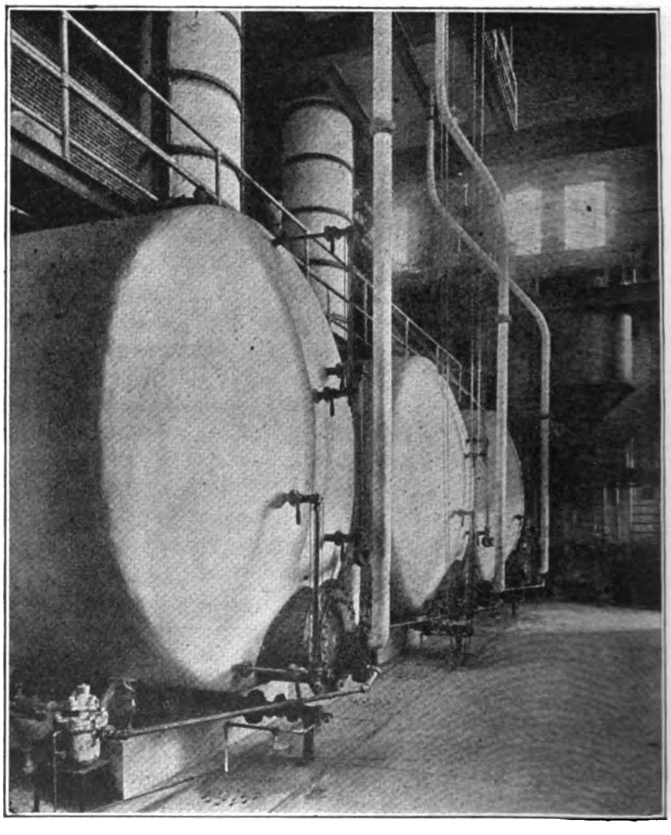
The equipment of the benzol house is a battery of column stills heated by steam and run without vacuum. The plant receives the crude benzol and crude toluol fractions from the light oil stills together with some of the closer boiling light crudes received in the plant. These crude fractions are first given a wash treatment with sulphuric acid in order to remove the unsaturated compounds, the wash taking place in vertical agitators. Following the sulphuric acid wash the materials are given a wash with caustic soda solution to free them from any sulphuric acid and are then charged into the stills. The stills are run to produce pure benzol, pure toluol and intermediate fractions which are redistilled. Products such as 90 per cent benzol are also made here.

The xylol department adjoins the benzol house, being separated from it by a fire-wall. The building and equipment are the property of the United States Navy. The plant was erected during the war to produce a pure meta-xylol for nitration to TNX (trinitroxylol). The stills are exactly similar to the benzol stills, the operation followed out being a distillation of a crude xylol fraction after washing to produce a meta-xylol of very close boiling range.

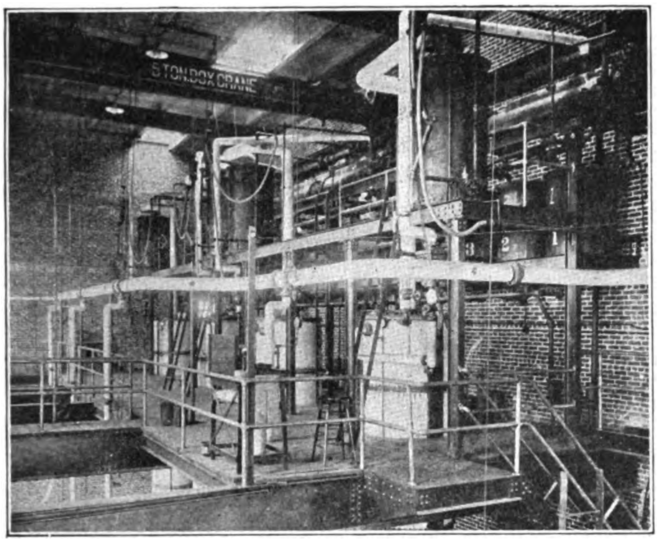
The Cumar plant involves three distinct operations, the first of these being the treatment of the "naphthalene-free" oil from the light-oil pan house for the removal of tar acids and pyridine bases. The tar acids are extracted from these oils in large vertical agitators with caustic soda solution, the carbolate so formed being finally allowed to settle and drained off. The pyridine bases are also extracted in special lead-lined agitators with dilute sulphuric acid. The pyridine sulphate solution so formed is removed in a similar manner to the carbolate. The agitators in this plant are also used for making up the more special tar acid containing oils, such as flotation oil, dip oil, etc., where the tar acid content must be very closely adjusted.

The second operation which takes place in this plant is the treatment of the fractions containing coumarone and indene from the light-oil plant to produce solvent naphtha, hi-flash naphtha and "Cumar" resin. The operation here consists of agitating the fraction to be treated with a small quantity of sulphuric acid, this treatment producing a polymerization of the coumarone, indene and similar materials in the oil. The polymerized product so formed stays in solution in the oil, which is separated from the acid and washed with caustic soda in order to entirely free it from acid. The oil is then subjected to distillation in steam-heated stills, the unpolymerized naphtha distilling over and leaving behind in the still a resinous residue known as Cumar resin. This resin, after all of the volatile oils have been removed by distillation, is drawn out into destructible drums and is ready for marketing.

The third operation carried on is the manufacture of emulsifying disinfectants. These products consist of a coal-tar oil, a soap, tar acids and water. In the cheaper grades of material the soap is a rosin soap, the process for the manufacture of the disinfectant



BENZOL STEAM STILLS; WASHER AT RIGHT



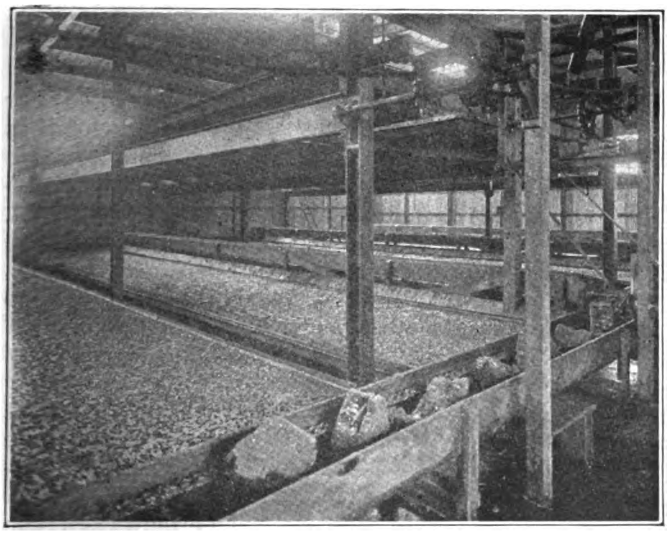
OPERATING PLATFORM BENZOL COLUMNS

being to introduce together into the disinfectant pot the requisite amount of rosin, caustic soda, oil and tar acids and heat until the mixture is entirely homogeneous. The oil used in these compounds is the napthalene-containing fraction after treatment for removal of naphthalene in the light-oil pan house and the freezing plant. For the higher grades of disinfectants the rosin soap is replaced by other soaps.

The object of the freezing plant is to remove the last traces of naphthalene from the naphthalene-containing oils after extraction in the Cumar plant. This is done with a view to obtaining oils which will not separate naphthalene on standing even at low temperatures. The oils are run into brine-jacketed agitators and are cooled down to a temperature of about —20 deg. C., the separated naphthalene being subsequently removed by running the oil through a centrifugal separator.

CRUDE CARBOLIC HOUSE

In the crude carbolic house the tar acids are recovered from the carbolate obtained in the Cumar plant. The process consists in an evaporation of the carbolate to the required concentration and blowing with carbon dioxide produced in small limekilns. The blowers are run in series, the fresh carbon dioxide entering first into the nearly saturated carbolate. The tar acids so produced separate in a layer and are allowed to settle and are drawn off. The crude acids are prepared for fractionation by heating in a simple still until the water is driven off. The aqueous carbonate solution is recausticized in a small horizontal agitator with milk of lime, the caustic mix so produced being filtered, giving a caustic solution which is used again for extraction of tar acids.

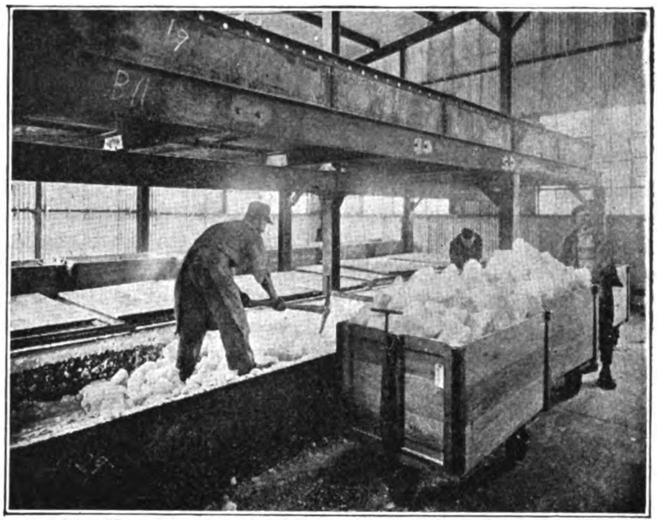


NAPHTHALENE CRYSTALLIZING PANS AND CONVEYOR

LIGHT-OIL ACID STILLS

The light-oil acid stills are fire-heated column stills similar to those in the light-oil department and are used largely for the fractionation of crude carbolic acid. The acid is distilled under vacuum and several cuts made containing various percentages of phenol and the cresols and xylenols. The fractions produced in this plant are accumulated and redistilled in the acid stills.

The acid stills consist of a battery of steam-heated column stills equipped to be run under vacuum, and handle the fractions produced in the light-oil acid stills together with some of the more refined crude carbolic acids. The plant produces a crude phenol, crude orthocresol, crude U.S.P. cresol, which is principally a mixture of meta- and para-cresols, together with some of the mixtures of higher boiling tar acids.



REFINED CRYSTALLIZED NAPHTHALENE

REFINED CARBOLIC ACID

In the refined carbolic acid house the crude phenol from the acid stills is subjected to a recrystallization treatment by mixing with a small percentage of water, allowing it to crystallize in ice cans and crushing and whizzing these cakes. The crystals so produced are of a high purity, but contain some water, which is separated from the phenol by a subsequent simple distillation. The cresol fractions are also subjected to a simple distillation in this plant, the principal object being to improve their color.

NAPHTHALENE

The crude naphthalene received from outside sources is melted up in a tank together with the crude naphthalene produced at this plant. The melted naphthalene is run out into large shallow pans in the pan house and allowed to cool slowly, the effect being a recrystallization of the naphthalene from the oil. The solidified naphthalene is broken out of the pans and subjected to the next stage of the process.

The crude naphthalene from the pan house is crushed and subjected to a whizzing treatment, this treatment removing the bulk of the adhering oil. The naphthalene is finally washed in the whizzers with a small quantity of warm water in order to complete the removal of the oil.

The purified naphthalene obtained from the whizzer is charged into fire-heated simple stills and subjected to distillation. The middle fraction of the distillate is accumulated and charged molten into lead-lined agitators with sulphuric acid with the idea of freeing the naphthalene of unsaturated compounds. After the sulphuric acid wash the still molten naphthalene is washed with caustic soda solution in order to free it from sulphuric acid and is then charged into the refined stills and subjected to redistillation. The bulk of the middle fraction from this redistillation is run to shallow pans and allowed to solidify. A portion of this naphthalene is used for subliming.

The naphthalene is broken out of the pans, after solidifying, with a pick and shovel and is crushed, the bulk of the crushed naphthalene so produced being packed as such. A portion of this material is run to the ball machines and other special molding machines, and is molded into the various forms demanded by the trade.

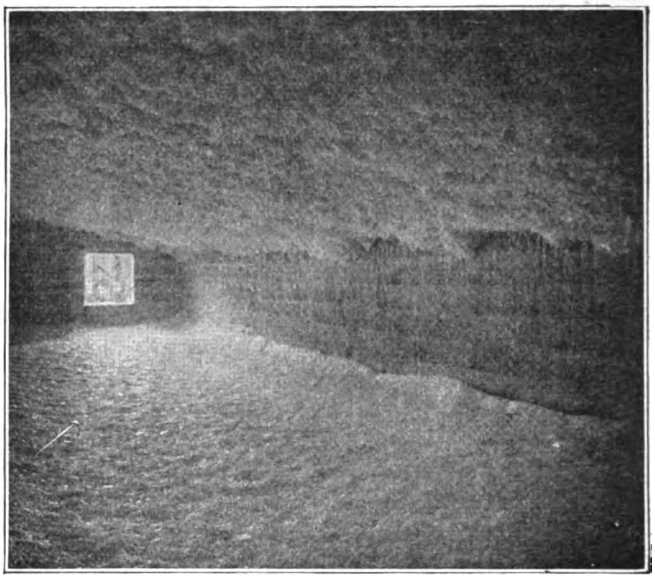
NAPHTHALENE FLAKE HOUSE

For the production of sublimed naphthalene, the refined distilled product is charged into deep pans situated at one end of the house and heated by steam-coils. The naphthalene sublimes from these into large rooms, where it condenses in the form of flake. These flake houses are run for considerable periods at a time and are then opened up and the flake naphthalene produced shoveled up and packed.

ANTHRACENE PLANT

The anthracene plant receives crude anthracene from other plants of the Barrett Company and works it up into refined anthracene and carbazole. The process followed for the purification of anthracene is to wash the crude with solvent naphtha in horizontal agitators, filter the mixture so produced and subject the washed anthracene cake to a similar treatment with pyridine. The solvent treatment has the effect of removing the adhering oil and the bulk of the phenanthrene, the pyridine treatment being principally for the removal of carbazole. The anthracene cake so produced is subjected to sublimation in a fire-heated pot in a current of air, the sublimed anthracene being collected in a large chamber and shoveled up and packed.

NAPHTHALENE BALL MACHINES


NAPHTHALENE SUBLIMING HOUSE

The pyridine liquor obtained from the pyridine wash of the anthracene contains most of the carbazole and is worked up for carbazole by distilling off the pyridine, washing the residue so obtained with solvent naphtha and subliming the crude carbazole so produced. The products of this process are an 80-85 per cent sublimed anthracene and an 85-90 per cent sublimed carbazole.

SYNTHETIC PHENOL PLANT

The synthetic phenol plant was constructed during the war to supply phenol for the manufacture of picric acid. The process followed was the Dennis-Bull and has been fully described in the chemical journals. The plant has now ceased operations.

BOILER HOUSE

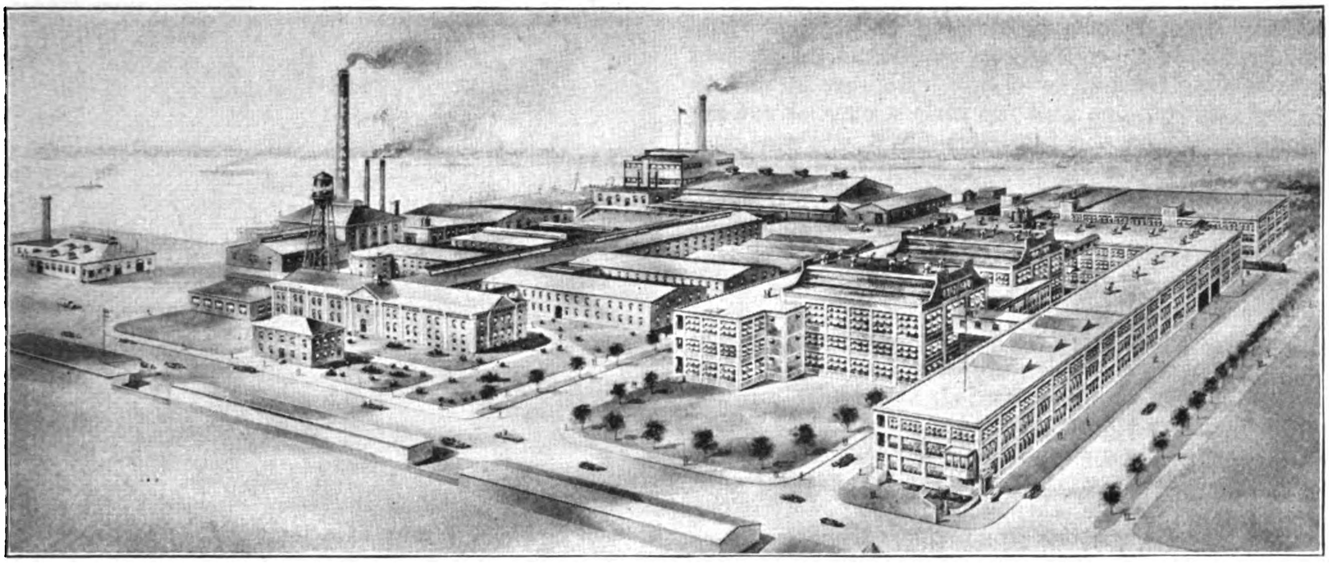
The boiler house equipment consists of four 500- and one 250-hp. B. & W. boilers and one 250-hp. Erie, giving a total boiler-horsepower of 2500. The boilers are equipped with Murphy stokers and with Cochran feed-water heating system.

FILTER PLANT

The filter plant produces all of the water used for such operations as condensing and cooling which is used in the plant. The equipment consists of two batteries of six horizontal sand filters and three centrifugal pumps and has a total capacity of 6,000,000 gal. per day. The water so produced on account of the filthy nature of the source is not suitable for process work nor for the boilers, for which the plant is also equipped with a supply of Philadelphia city water.

LABORATORY

The laboratory building is a three-story structure housing both the routine control laboratories and the research laboratories. The first floor is mainly occupied with offices, washrooms, etc. The second floor is given over to the routine plant control work, and the upper floor is divided into several individual laboratories devoted to research work.



BIRDSEYE VIEW OF WELSBACH CO. PLANT

The Welsbach Co. Plant

The manufacturing plant of the Welsbach Co., located at Gloucester, N. J., just across the Delaware River from Philadelphia, Pa., is a development of many years of commercial operation and chemical research in the incandescent gas mantle industry, and the processes now employed therein are representative of the present state of the art. The manufacturing operations are resolved into three main departments, namely, mantle manufacture, fixture manufacture and chemical production. Each of these departments is subdivided into units, and a thorough inspection of the workings as a whole reveals an enormous amount of detail. The diversity of this detail at once seizes and holds the interest of the visitor.

Mantle Manufacture

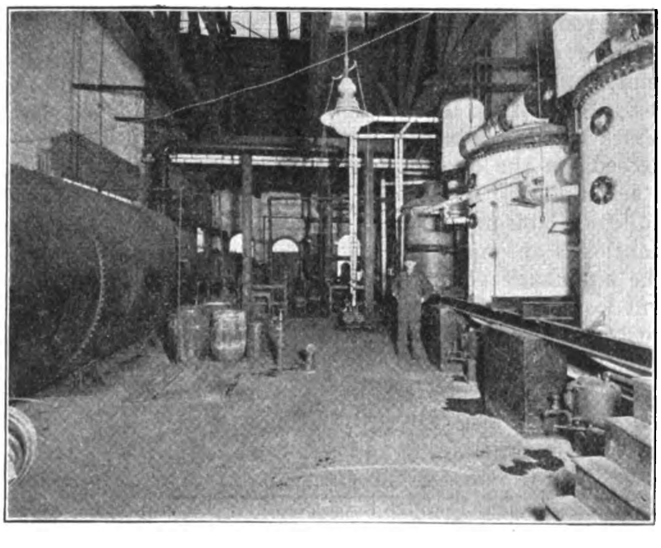
The first step in making the gas mantle is the knitting of the cloth tubing or webbing to form a base for the physical shape of the mantle on which the thoria-ceria mixture is to be constructed. This tubing is woven from ramie fiber thread, produced from the ramie plant, similar to linen and a native of India; cotton thread and silk thread. Ramie thread is used for inverted mantles, cotton for upright mantles and silk for the highest grades of either type. Silk is by far the best fabric, leaving the smallest amount of foreign ash in the finished product. Automatic knitting machines, employing both the chain and the rib stitch, weave the tubing into long lengths, made endless by hand sewing, and the diameter of which is considerably greater than the ultimate diameter of mantle desired. This is to allow for shrinking of the structure during subsequent process of hardening. The machines are manufactured by the Wildman Mfg. Co. and the knitting department has a capacity of 20 miles of tubing per day, consuming 1500 to 2000 lb. of thread, or, in other words, enough fabric is manufactured for the production of 1,000,000 mantles per week.

The washing room adjoins the knitting department and the air for both is so thoroughly purified by a Carrier Engineering Corporation washer that it is impossible to detect any particles of solid matter floating in the sunlight as under ordinary circumstances.

The water used in washing the tubing and for dilution of the chemicals so employed is of extreme purity, being continually tested, and if over 5 parts of solid matter in one million parts of water is in evidence, the whole is discarded. This is an important detail, since any appreciable amount of foreign matter entering the flow weakens the finished mantle and causes its rejection by the inspectors. The water is therefore distilled in a J. P. Devine Co. multiple effect apparatus located in the power house and conducted to the various departments through tin lined lead pipe. About 20,000 gal. is consumed daily in the washing process.

The washing room operation requires four days' time to thoroughly cleanse the fabric. The equipment consists of six large circular tanks with smaller auxiliary vats and Troy Laundry Machinery Co. centrifugal wringers. Overhead revolving spools are used to convey the webbing through the process.

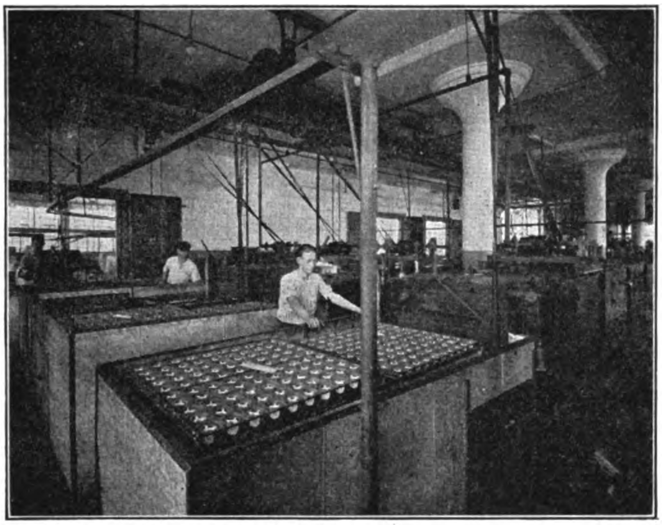
After a final neutralization and drying in the centrifugals the material is conveyed to a large Proctor drier, manufactured by the Philadelphia Textile Machinery Co., and remains therein about 25 min. at a temperature of 130 deg. The drying process is continuous, with the material moving along through the dry box on revolving spools.



DEVINE WATER DISTILLING APPARATUS

The saturating department receives the webbing and soaks in a solution of approximately 99 per cent thorium nitrate and 1 per cent cerium nitrate, the time in the bath being from 15 to 30 min. Between 30 and 40 different solutions are used for various mantles and selection depends on the type of product and raw material involved. A colored dye is added for tracing various lots through the factory. The work is carried on in small rubber boxes to the end of which are attached hand wringers, for partially drying.

The wet material from the wringers is cut into 90-in. lengths and slipped over wooden poles by hand. Care must be taken to stretch the mesh of the fabric evenly along the pole. The poles are then hung in a large drying room for a 30-min. period, and where the wet bulb temperature 110 deg. F. and the dry bulb temperature 80 deg. F. is maintained by thermostatic regulation. Curve drawing recording meters are installed at all such locations throughout the factory. The recorders and thermostats are furnished by the Tycos Co. Bristol recorders are also extensively used.

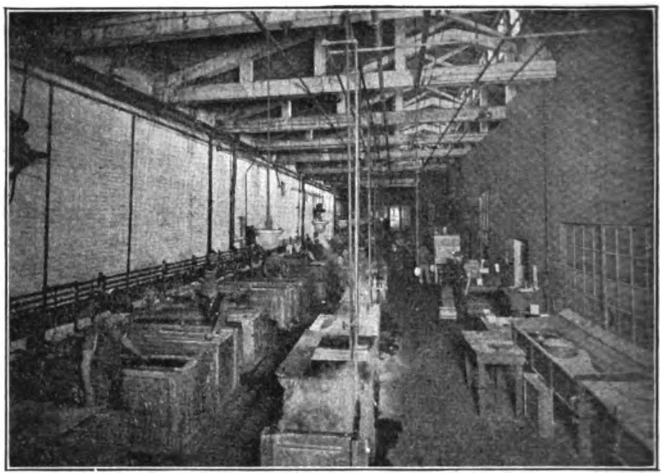


FEEDING TRAYS OF MANTLES TO AUTOMATIC DIPPING MACHINES

The dried lengths are placed flat in bundles and cut to mantle length by rotating knives. The open end of a mantle is dipped in fixing solution by machinery, the drawstrings of asbestos or treated thread are put in by hand and the finished structure is sent to the hardening rooms.

There are two divisions of the hardening department, one for the upright and one for the inverted mantles. Hardening is accomplished by placing over gas flames where a mixture of gas and air is carefully regulated. In the case of upright mantles the regulation is accomplished by hand work of skilled operators over multiple bunsen burners. The burning of inverted mantles is automatically regulated in multiple crucibles. The shrinkage occurs during this process and a 3 per cent loss of product is incurred in the upright mantles, with a 30 per cent loss in the inverted type. This department consumes 160,000 cu.ft. of gas daily.

The mantles, now consisting of an ash of thorium and cerium oxides, are carefully conveyed in trays, 100 per tray, to the dipping and packing room. These trays enter the automatic dipping and drying machines, manufactured by the Welsbach Co., where the collodion coating is put on and dried. Time required for this operation is 15 to 20 min. at a temperature of 80 deg. C. This coating protects the ash against breakage until it is burned off in the lamp of the consumer. The department operates four banks of three machines each, and delivers the trays of mantles ready for packing. The collodion fumes from the drying boxes are recovered by small exhausters, shown located over the boxes, and returned to the collodion plant for absorption. An annual saving of about $10,000 is effected through this feature.

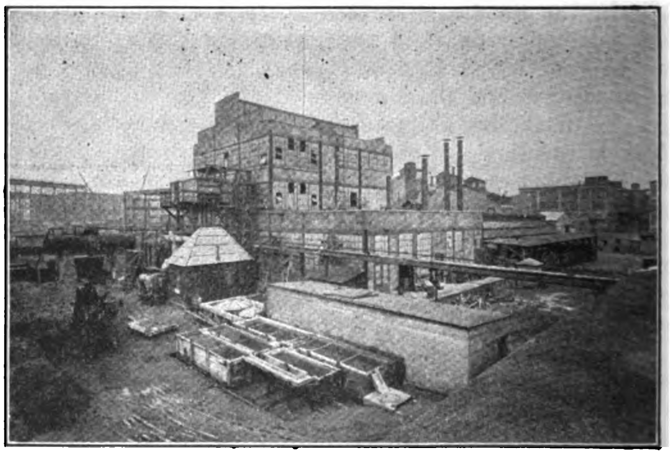


ELECTROPLATING DEPARTMENT

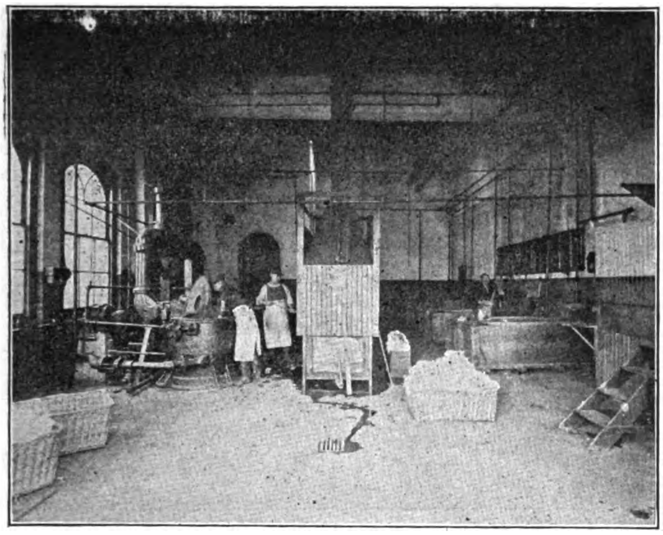
The packing and assembling of the finished product embraces a complete system of belt conveyors and elevators for delivering the numerous types of boxes to overhead bins and for placing the finished package in the shipping department. The best grades of upright mantles are placed in nichrome wire supports before packing.

As the packing is in progress the preliminary inspection is carried on and rejects are sent to the final inspector, who destroys all imperfect ones by crushing in the hand. No secondary products are marketed. This rejection of defective mantles is an indication of the high quality of the article sold to the consumer. The majority of defects is due to the unavoidable entering of impurities into the early stages of the process.

A complete paper box factory makes all forms of packing containers, including the printing of labels. The paper tubing is produced from strawboard 0.017 in. thick in 10 to 15 ft. lengths and of all diameters. The company has experimented long to arrive at the proper glue for this tubing and has finally obtained a



CHEMICAL PLANT

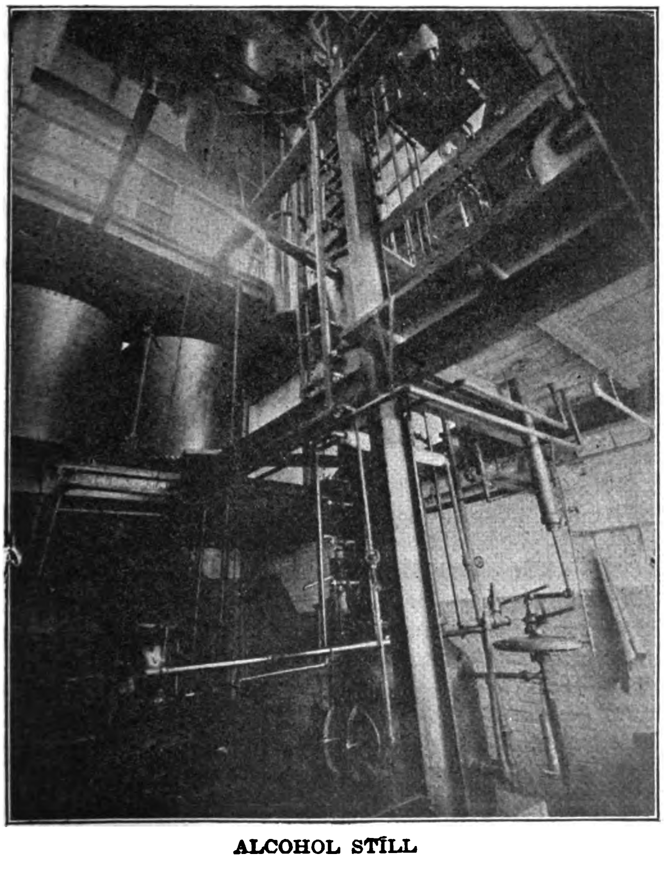


COTTON NITRATING PLANT

satisfactory article in a cold glue, made from potato and tapioca dextrines. (Arabol Co. glue No. 4604c.)

The paper caps for the circular boxes are drawn from circular stamped blanks, the cutting and drawing operation being accomplished on the same punch press. In order to draw these caps successfully it is necessary first to soften the rolls of strawboard by moistening with a mixture of equal parts of tallow and soft soap. This mixture is made in a small tank overhead and applied by passing the strawboard ribbon over a roller which dips in a small vat of the solution, before being fed to the presses.

The rectangular paper boxes are produced on both automatic and hand-fed machines. The smaller sizes are carried to their respective wire mesh bins by air suction, or by belt conveyors to the packing department. Fifty to 60 tons of paper scrap is recovered and baled each week. The printing department is completely equipped with cylinder and platen presses.

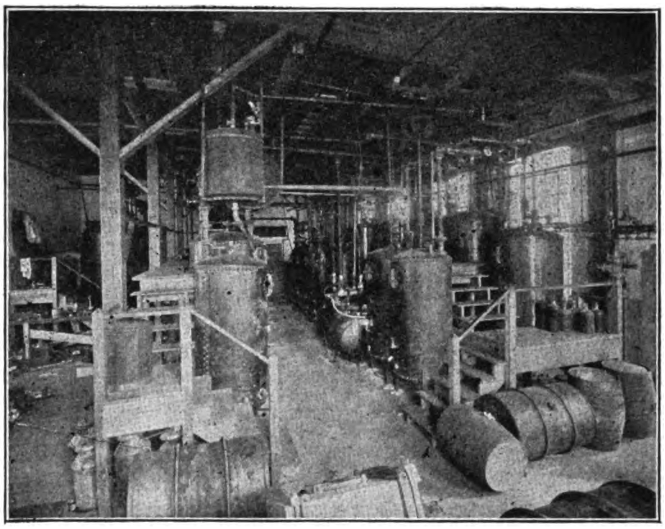


ALCOHOL STILL

This factory employs the Brightwood box machine, the Inman box machine, the Knowlton stay machine and metal edge machines made by the National Metal Edge Box Co. The Welsbach Co. has also manufactured a number of the automatic box machines in operation.

FIXTURE MANUFACTURE

An extensive fixture factory produces all types of fixtures and fixture parts required by the gas illuminating trade, from the smallest mantle supports to the latest type of indirect lighting bowl. The pattern shop and foundry makes malleable iron, brass, aluminum and composition castings. One section of the machine shops contains automatic screw machines and multiple spindle drill presses; another contains batteries of punch presses, and the third a number of lathes. A complete tool-making department is operated in conjunction with these shops. A sheet metal department manufactures the necessary fixture parts.



COLLODION PLANT

The electroplating department is capable of producing any desired finish on the fixtures and protecting with suitable lacquer. One of the most recent developments in this work consists of a tumbling barrel, equipped with electrodes for plating while the polishing operation is in progress. The wooden barrel revolves with the axis supported at an angle of about 45 deg. One electrode is attached to the revolving mechanism while the other is suspended vertically in the solution through the open end of the barrel. This is shown in the background of the picture.

The fixture assembling rooms occupy a large floor space and it is here that minor machine operations are carried on and the manufactured parts are assembled to produce the completed fixture.

The machine shop employs Brown & Sharpe hand and automatic screw machines, Warner & Swazey hand screw machines, and Avery drill presses. The power punch presses are of three makes, namely, Ferracute, Bliss, and Henderson. Foot presses are made by Waterbury and Farrel companies.

The section of the works which is perhaps of greatest interest to CHEMICAL & METALLURGICAL ENGINEERING readers is that in which collodion is made and where the rare earths in the form of monazite sands are reduced to secure thorium, cerium, mesothorium and radium compounds.

Collodion, as used to hold the physical structure of the thoria-ceria mantle intact during commercial handling, must have special characteristics to serve this purpose. It must be non-shrinkable when drying, otherwise the oxide structure would be destroyed and the mantle would crumble when collodion is burned off by the ultimate consumer. It is further necessary that collodion be pure and a reliable source of supply be at hand.

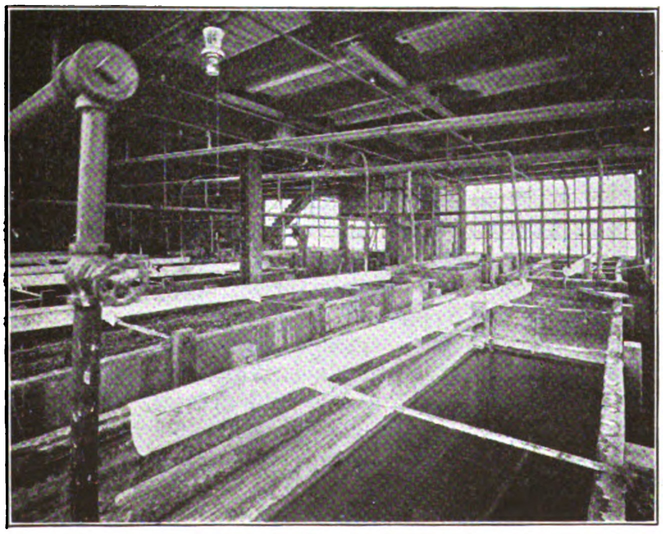
The plant produces from 10,000 to 15,000 kilos per month, the entire amount being used in the mantle factory. The cotton is nitrated under cleanest possible conditions, dried in a centrifugal wringer and the process carried to final conclusion in an apparatus of collodion plant, as shown.

The feature most worthy of note is the method employed in conducting the collodion to the dipping machines. The piping system is made up of double pipe and fittings throughout. The inner pipe carries the collodion, while the annular space between the inner and outer metal is filled with inert gas (CO_2) under higher pressure than that required to force the liquid through the inner pipe. In case of leak in the inner wall the gas will enter the central conductor and force the collodion back to the tanks. While this system is expensive to install, it is considered invaluable as an insurance against accident where explosive or inflammable liquids are transported. It is said to be required by law in Berlin where gasoline is stored in excess of 5 gallons.

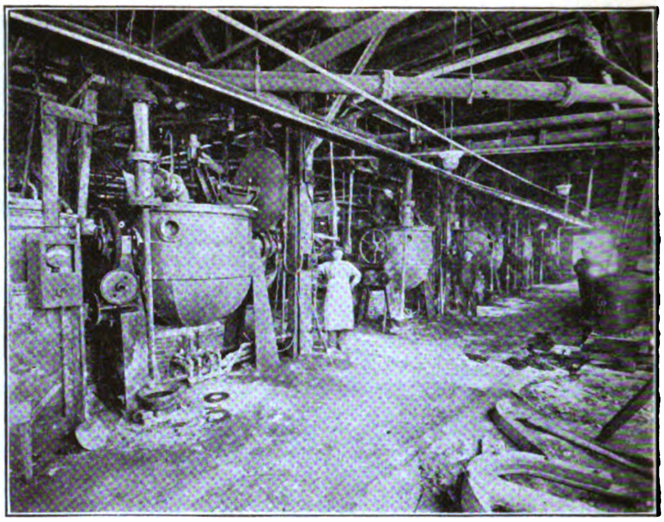
An alcohol still is operated in connection with this plant, while ammonia is also distilled in an adjoining room. The product of the latter is used in the fabric washing process.

RARE EARTH REDUCTION

The monazite sands consumed at the present time are purchased in Brazil, where they can be obtained more cheaply than the Welsbach Co. can mine them from its Carolina properties. This is due to the fact that the latter deposits are in widely scattered pockets and economical mining operations therefore do not obtain. The ore, or beach sands, occurring in placer deposits near the coast of Brazil is subjected to wet concentration over jig tables, where the monazite, being the heavier, is separated out from the gangue or silicas. The concentrate, however, still contains the garnet, and after being dried a further separation is made by electromagnetic means in a manner similar to that employed in the zinc industry.



PRECIPITATING TANKS



MONAZITE SAND DIGESTORS

The final product shipped contains about 90 per cent of the monazite crystals which were present in the crude ore, and is in the form of a rather uniformly grained, fine, yellow sand. A typical analysis of this product shows the following content:

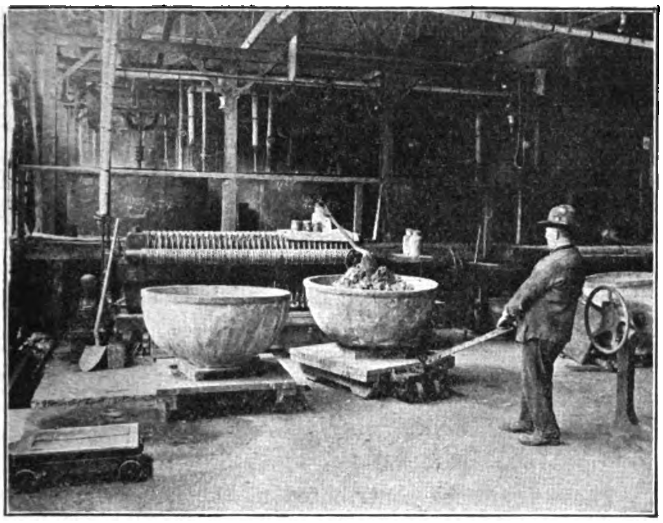
	Per Cent		Per Cent
Phosphoric anhydride	28	Thorium oxide	5
Cerium oxide	30	Yttrium oxide	2
Lanthanum oxide	14	Iron oxide	5
Neodymium oxide	16	Calcium oxide	
Praseoudymium oxide			100

The sand is received at the Welsbach works in 100-lb. bags containing 5 to 6 per cent of thoria, the substance most desired in the separation. Definite quantities are mixed with the proper amount of sulphuric acid, with sp.gr. above 66 deg. Baumé, in the digestors, where the mass is agitated under heat for a period of 6 to 8 hours.

The heat is applied below and retained close to the kettle by a sheet steel jacket as shown. The kettle is cast from a special grade of acid-resisting iron. During the heating period, heavy SO_2 fumes are driven off through the cast pipe as shown on the left of the kettle and are conducted to a 16-tube, 85,000-volt Cottrell precipitator. This latter may be seen outside the chemical plant buildings. Its use is necessary to the protection of the surrounding community from the fumes, and a considerable quantity of acid is also recovered.

When the operation is completed, the heat is shut off, but the agitator is kept running, and the tee in the SO_2 line is disconnected from the kettle. The top cover is also removed for the pouring. The removal of the tee permits the apparatus to be turned on its trunnions, in a manner similar to the operation of a bessemer converter, and the pasty mass, consisting of phosphates and the sulphates which have formed, is dumped into a lead-lined receiving vat. This vat, located on the side opposite that shown in the picture, with its top about 1 in. from the floor level, is filled with water at the time of pouring.

The solution is pumped from these vats, one for



CAUSTICIZING TANKS AND SPERRY FILTER PRESS

each digestor, to the second floor tanks, where it is further diluted. This dilution precipitates the rare earths (about 70 per cent of the sulphates and 3 per cent of the phosphates), which are separated from the liquor in Sperry filter presses on the floor below. The sludge then enters a long series of operations, requiring several weeks, carried on in circular tanks with mechanical agitators. Part of this work involves boiling with caustic to produce hydrates, the object of the whole performance being to remove the residual phosphates. These hydrates are eventually dissolved in hydrochloric acid to form chlorides.

It is about this point that the separation of the thorium and cerium compounds is made, and the large part of the work from here on consists of refining the thorium and such quantity of the cerium as is required. The equipment embraces several batteries of glazed earthenware bowls, made by General Ceramics Co., placed under mechanical stirrers as shown in the picture. Practically all the moving parts of this apparatus were made in the company's shops. A new caustic recovery evaporator made by the F. D. Stokes Machine Co. has just been installed.

When the thorium group is split off from the cerium, about 95 per cent separation of thorium present is recovered. The radium and mesothorium comes down with the thorium. The cerium residue is about 50 per cent pure and is known to the trade as commercial cerium. It is sold to the carbon manufacturers for use in flaming arc lamp carbons. Its presence in minute quantities greatly adds to the incandescent light in both mantles and carbons. It is also purified and used in medicines such as cerium oxalate. The Welsbach Co. prepares these compounds for the market. The cerium nitrate used in the mantle fluid is necessarily refined to a purity equaling that of the thorium nitrate.

The complete process from the time the sand is placed in the digestors until the pure $Th(NO_3)_4$ is extracted consumes a period of from 2 to 3 months. The plant produces 10,000 to 15,000 kilos per month. Quantities are shipped to Great Britain at the market price of about $10 per kilo. This trade was built up when the supply from Germany was cut off at the beginning of the war.

The supply of radium from Colorado ores is limited and practically the entire output is required for medical purposes. The manufacturers of articles like radiolite watches are therefore forced to search elsewhere for the raw luminous material. The Welsbach Co. has successfully undertaken the manufacture of a mixture of radium and mesothorium to supply this need.

An examination of the chemistry of these two substances reveals parallel characteristics and compounds. The principal difference in the two lies in the fact that the activity of mesothorium continues about seven years, while radio-activity is constant over several hundred years.

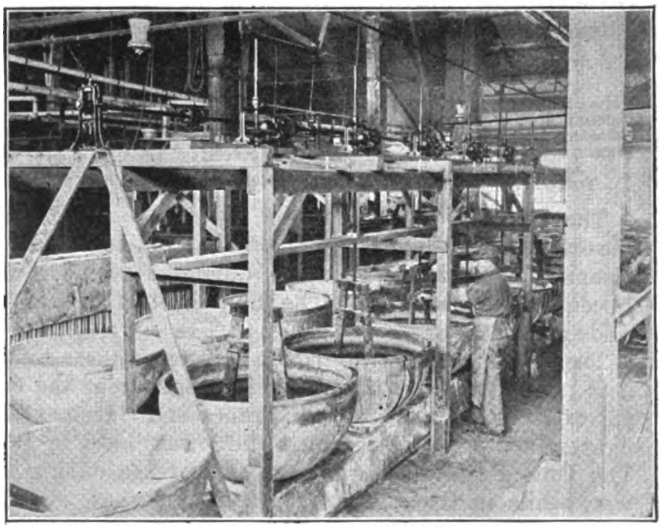
The extraction from the rare earths begins in the thorium plant and a residue of approximately 20 lb. per day is obtained from the thorium purification process. This residue is taken to the radium laboratory, where it is dissolved as a chloride in the so-called zero kettle. From this it is taken through a series of 5 pairs of steam-jacketed kettles, Elyria Enamel Products Co. make, then through a similar set of evaporating dishes. The work consists of a series of precipitations and crystallizations.

The final residue from the chloride solutions is then redissolved as a bromide and the process continues as before, but on the laboratory bench. The solutions pass through about 30 operations in all. For each ton of monazite sand originally treated there is produced one milligram of the rare element mixture.

OTHER DEPARTMENTS

The company generates power from coal delivered to the bunkers by barge on the Delaware River. Bucket elevators and belts carry to the overhead bins, from which it is automatically weighed to the bank of three Babcock & Wilcox boilers, fired by Riley-Sanford plunger type stokers. Boiler draft is supplied by two Sturtevant fans, direct-driven by steam turbines. The plant is so equipped with measuring and recording devices as to furnish complete data on daily performance. This apparatus includes Hays CO_2 recorders, Venturi boiler feed water meters, and General Electric steam flow meters.

The engine room contains one 400-k.v.a. 2300-volt 3-phase 60-cycle Crocker-Wheeler Co. generator direct-connected to tandem Corliss engines and with belt-driven exciter; one 150-k.v.a. 2300-volt 3-phase 60-cycle General Electric Co. generator direct-connected to vertical type American Ball engine; one 7-panel switchboard equipped with General Electric instruments, ITE



MIXING BOWLS

circuit breaker and switches, including control for operating the two generators in synchronism during peak load periods.

The laboratory and testing department embraces complete research and control chemical laboratories, and physical laboratories equipped with mechanical devices for shock and tensile tests of mantle materials together with apparatus for candle power and life tests on finished mantles.

The plant buildings are of fireproof construction, with Grinnell sprinkler systems. Distilled drinking water is supplied throughout. A complete hospital is equipped for emergency treatment.

The system of conveying materials requires little hand trucking within the works. The storehouse operates Elwell-Parker electric trucks, equipped with Edison storage batteries, for conveying crates within the building. For heavy outside work Pierce-Arrow 2- and 5-ton trucks are employed. The coal loader shown in foreground of "Chemical Plant" picture is made by the Link Belt Co.

The business of making incandescent gas mantles is said to be continually on the increase in this country. Ten per cent of the Welsbach Co.'s output is consumed abroad. The marked growth of the industry is attributed to the fact that an excellent light is secured at a reasonable rate, wherever gas is available. It is probable that the development of the by-product coke oven is giving an impetus to the business.

The writer desires to acknowledge the courtesy of the Welsbach Co. as extended by Dr. H. S. Miner and Mr. C. E. Bliss during preparation of this article.

World Iron and Steel Output

The National Federation of Iron and Steel Manufacturers of Great Britain has issued a memorandum on the world's output of iron and steel, which contains a statistical survey for several years past. Below are given those figures which have not hitherto been published with those of previous years for purposes of comparison. The production of pig iron and steel in the leading countries was as follows:

PIG IRON PRODUCTION

	1918	1917	1916
United Kingdom, gross tons	9,066,000	9,420,000	9,048,000
United States, gross tons	39,052,000	38,621,000	39,435,000
Germany, metric tons	11,590,000	13,142,000	13,285,000
France, metric tons	1,297,000	1,684,000	1,447,000
Total	61,005,000	62,867,000	63,215,000

STEEL PRODUCTION

	1918	1917	1916
United Kingdom, gross tons	9,591,000	9,840,000	9,196,000
United States, gross tons	45,073,000	45,061,000	42,774,000
Germany, metric tons	14,874,000	16,587,000	16,183,000
France, metric tons	1,912,000	2,232,000	1,952,000
Total	71,450,000	73,684,000	70,105,000

The German production for 1918 does not include the output of Luxemberg, the Saar District, and the disannexed Lorraine Province during November and December of that year. The British steel figures include steel castings.

The first and most significant feature of these tables, it is pointed out, is the fall during the war of the output of iron and steel in both France and Germany, the figures in both cases reaching the lowest level in 1918. The United States shows a great increase during the war, while in Great Britain the figures show a fairly constant output of pig iron and an increased output of steel.

In the case of pig iron the production of these four countries in 1900 amounted to 34,000,000 tons, of which Great Britain produced 9,000,000 tons. In 1913 the total output had risen to 66,000,000 tons, of which Great Britain produced 10,000,000 tons, while in 1918 the total had fallen to 61,000,000 tons, of which Great Britain produced 9,000,000 tons.

The production of iron and steel in countries of the second rank in 1916 and 1917 is given as follows:

	Pig Iron		Steel	
	1917	1916	1917	1916
Austria-Hungary	....	2,418,000	2,921,000	3,330,000
Canada	1,046,000	1,070,000	1,550,000	1,287,000
Italy	475,400	467,000	1,304,000	1,269,000
Russia	....	3,738,000	....	....
Sweden	829,000	733,000	581,000	614,000
Belgium	....	127,825	....	95,830

These countries contributed at the outbreak of war about 9,000,000 tons of pig iron and 12,000,000 tons of steel to the world's production. The figures for Italy are significant of the extent to which that country has relied on scrap steel and imported pig iron to obtain steel output.—*Fortnightly Information Review, Aug. 1, 1919.*

How to Relieve "Brass Itch"

The symptoms of brass poisoning and the treatment which should be given are described in the current issue of *Modern Medicine*, Chicago, Illinois, by Dr. R. P. Albaugh, formerly director of the Division of Industrial Hygiene, Ohio State Department of Health.

The symptoms are evident for several hours after exposure to the fumes which are contained in the whitish smoke and sublimation products from molten brass and zinc. The symptoms start with a dry, parched throat, an irritating and unproductive cough, a feeling of constriction in the chest, lassitude, and anorexia, often followed by nausea and vomiting; a headache sometimes develops and chilly sensations are noticeable within one to four hours.

The chills rapidly verge into a distinct rigor which lasts from one and one-half to two or three hours. The application of warm clothing or external heat seems not to diminish the rigor of a chill. Muscular cramps and sharp pains in the joints usually accompany the chill.

The symptoms end rather abruptly, almost by crisis, and are followed at once by a profuse perspiration. The patient will probably fall into a deep sleep following the stage of relaxation and without any apparent ill effects.

Brass poisoning does not occur from handling of the metal or the zinc alloys which go into its composition, but is limited to those exposed to the inhalation of the whitish smoke and sublimation products from the molten metal.

There is no specific treatment for brass poisoning, "brass itch" and "brass chills." Zinc is supposed to be responsible for the bad effects. The affection was formerly confused with malaria.

Some workmen find relief in drinking hot milk to which pepper is added. A good purge also seems beneficial. Dr. Albaugh advises the prevention of brass poisoning by better hygienic arrangements in foundries and smelters, elimination of careless habits of workmen, and large, roomy quarters.

Physical Measurements for Students of Chemistry

Mr. Paul E. Klopsteg of the Leeds & Northrup Co., Philadelphia, presented an appeal in a late number of *Science* for courses in physical measurements for students of chemistry and allied sciences. It appeals to us as sound doctrine, and while the subjects may be included in the curricula of various institutions, we know from experience that an adequate familiarity with them is by far too often lacking among young chemists and Mr. Klopsteg's proposal would seem to cover an important gap.

Although engineering is commonly spoken of as applied physics, the bridge between the pure and applied science in this sense has stretched itself to such amazing lengths that many physicists and many engineers do not attempt to cross it.

Mr. Klopsteg proposes that, in addition to the regular course in general physics, a special course in physical measurements be provided in the senior college year for students who contemplate either graduate work or an immediate entry into industry. He suggests that it occupy at least the equivalent of three 2-hr. periods for one semester of 16 weeks and proposes the following general topics as representing the essential things from which a selection might be made.

(1) The accurate measurement of long and short time intervals.

(2) Measurement of temperatures by methods other than the mercury thermometer. Principles of pyrometry.

(3) Temperature regulation and temperature regulators and controllers.

(4) Principles of precision calorimetry.

(5) The microscope; its theory, and application to the measurement of small lengths.

(6) The reading telescope and its application to the measurement of small angles.

(7) Measurement of refractive index; spectrometer and refractometer.

(8) The spectroscope, and spectroscopic analysis.

(9) Color and colorimetry; intensity of light and photometry.

(10) The polariscope and polarimeter.

(11) The galvanometer; its use as a deflection and as a null instrument.

(12) Ohm's law; measurement of current and potential differences.

(13) Electric power and heating.

(14) Resistance measurement; Wheatstone's bridge, with application to measurement of electrolytic conductivity. The alternating current galvanometer as applied to conductivity measurements.

(15) The potentiometer; application to measurement of thermo-electric forces, electrode potentials, ionic concentrations.

(16) Electrometers and electroscopes; applications to measurements in radioactivity.

(17) Principles of X-ray measurements.

Personal

Dr. F. C. Brown has resigned his position as associate professor of physics, University of Iowa, to accept a position as technical assistant to the director of the Bureau of Standards.

Mr. James L. Bruce has resigned as manager for the Butte & Superior Mining Co. to become general manager for the Davis-Daly Company.

Mr. Alfred Burton, who was engaged with the explosives committee of the Imperial Munition Board, Ottawa, Canada, has accepted a position with the Dominion Dyers, Ltd., London, Ontario.

Mr. Rex Honey, formerly connected with the Dominion Forest Products Laboratory, McGill University, Montreal, has been appointed head of the service department of the Abitibi Power & Paper Co., Ltd., Iroquois Falls, Ontario, in charge of efficiency research and raw materials.

Dr. F. M. G. Johnson, who has been research chemist for the Canadian Consolidated Rubber Co., Ltd., will again be associated with the chemical department at McGill University, Montreal.

Mr. Charles W. McKay has recently become associated with the industrial engineering firm of L. V. Estes, Inc., Chicago, Ill.

Dr. C. Ferdinand Nelson has been elected professor of biological chemistry and head of the department of physiological chemistry which has recently been established at the University of Kansas.

Mr. Arthur Phillips has been appointed assistant professor of metallurgy in the Sheffield Scientific School, Yale University, New Haven, Conn.

Mr. Warren C. Prosser has resigned as superintendent for the Red Mountain Mines Co., to return to professional work in mineral and oil land investigations, with headquarters at Denver.

Dr. J. W. Shipley, professor of chemistry, Manitoba Agricultural College, has resigned to accept an appointment as assistant professor in chemistry, University of Manitoba.

Mr. A. B. Shutts has become general manager for the American Ores and Asbestos Co., Globe, Arizona.

Obituary

Mr. Frank Cochrane, Minister of Lands, Forests and Mines in the Ontario Legislature, died on Sept. 22 at Ottawa.

Mr. Herbert G. Thomson, a graduate of the University of California and general superintendent for the Nevada Packard Mines Co. at Lower Rochester, Nevada, died on Sept. 25 from injuries received in a fall into a shaft while sampling ore.

Mr. Henry B. Underhill, president of the Selby Smelting & Lead Co., died at his residence in San Francisco on Sept. 14.

Current Market Reports

The Non-Ferrous Metal Market

Tuesday, Oct. 14.—There has been no large transactions in the non-ferrous markets during the past week.

Aluminum:—Transactions are largely made on direct contract between producers and consumers. The open market does not show important activity; 98-99 per cent ingots are quoted at 32-33c. lb.; cast scrap, 24½-25c.; sheet scrap, 23-24c.; and clippings, 26½-27¾c.

Antimony:—On 25-ton lots the price is 8½c. and on broken lots 8⅝c. Prices have remained steady in spite of the falling off of the demand by ordnance supply manufacturers. The patent glazed kid leather trade is reported to be using considerable quantities.

Copper:—The close of the war found great supplies of commercial copper alloys such as brass and bronze made up, and

Lead:—The market for lead has continued to strengthen. East St. Louis now quotes at 6.3c. and New York 6½c. lb.

Tin:—Incoming tin continues to be tied up in the port due to the strike of the longshoremen. Small stocks are being held at 57c. lb.

Zinc:—Zinc continues at 7.65c. both in New York and St. Louis.

OTHER METALS

Bismuth	lb.	$2.95 —	......
Cadmium	lb.	1.50 —	1.75
Cobalt	lb.	2.50 —	3.50
Magnesium	lb.	1.75 —	2.10
Mercury	75 lb.	80.00 —	95.00
Nickel	lb.	.41 —	.45
Iridium	oz.	175.00 —	......
Palladium	oz.	115.00 —	120.00
Platinum	oz.	130.00 —	......
Silver	oz.	1.18⅛ —	......

The Iron and Steel Market

The iron and steel strike has been waning since last report, but at a very slow rate. This review covers the fourth week of the strike. At the inception the appraisal of the manufacturers was that if the strike should seriously cripple the majority of the producing districts it would probably be a long drawn out affair, a matter of say two to four months, but that if some districts, including the Pittsburgh district, could be kept operating moderately well the strike would play out in a very few weeks, say from two to four weeks.

The strike started out by agreeing with the second alternative, since it left Western Pennsylvania in fairly good operating condition, and did not curtail production in the whole industry by as much as 50 per cent, but now, after four weeks, it is not receding as rapidly as it was expected to do with such circumstances. The number of men at work in the Pittsburgh district increases day by day, but even with the spectacle of nearly all the mills running in good shape some strikers still stay out.

It was problematical when there would be any considerable return of men in the strike districts where the stoppage of production was complete, and where the breaks would first occur. The first district to begin resumption proves to be the Mahoning Valley, but instead of the beginning marking a stampede the men are returning to work very slowly. In that valley there are 27 blast-furnaces, of which 22 were active just before the strike, and all were closed by the end of the second day. Now only about five are operating, and it is understood they are not in all cases approaching normal tonnage. At least three of the four large open-hearth producers in Youngstown are producing a little steel, having only a few furnaces operating. So far as known only one bessemer converter is operating.

TONNAGE OUTPUTS

The ingot production report for September has not been issued yet, but as the strike began on the 22d the report would not be illuminating. The August report showed production of steel ingots in the industry as a whole at the rate of about 39,100,000 gross tons a year, and except when, as during the war, there is an abnormal distribution of steel among the different finished lines, the finished rolled steel output runs at about 76 per cent of the ingot tonnage. With a trifling increase over the August rate, there would have been a rate just before the strike of about 2,500,000 gross tons of finished rolled steel a month. At its maximum the curtailment was more than 40 per cent, but hardly as much as 50 per cent, and at the end of the first 30 days of the strike the production rate is about 60 per cent. Thus the first month of the strike witnessed a loss in output between 1,000,000 and 1,250,000 gross tons. Should a quick return of men to work begin in the next week or two output would require several weeks for even an approximate return to normal, and nearly a million tons more would be lost after the first month, so that the minimum loss in tonnage may be set at 2,000,000 tons. The maximum, even if the strike continues to wane only slowly, as at present, would be unlikely to exceed 3,000,000 tons.

The steel market has of course been very quiet. Mills are booking some contract tonnage from regular customers, merely as a routine matter. There is no mill in position to take on orders for early deliveries. Consumers continue to show the utmost patience in the matter of deliveries, assuring producers that while they wish to know what deliveries may be expected they are anxious not to embarass the mills by making requests for deliveries.

Stocks in consumers' hands seem to be holding out fairly well, and probably somewhat better than was expected. It is quite certain that there were no large stocks anywhere, and that the production before the strike was passing directly into consumption.

PIG IRON

There has been active buying of pig iron in the East, where some consumers are short on account of the strike curtailing output at Buffalo, while the eastern Pennsylvania and Virginia furnaces are not affected by the strike. No. 2 foundry delivered Philadelphia, $30.60 in September, is now up to $32.10. The Pittsburgh and valley markets are unchanged and show only a moderate demand, merchant pig iron production in that section being very slightly affected by the strike.

The Chemical Market

New York, October 20, 1919.

The delays in making deliveries and the holding up of export business, brought about by the various labor disputes, have reduced inquiries on many commodities and tied up business to a great extent. Manufacturers of coal-tar products are bending their efforts toward meeting all contracts, and their interest in the spot market is therefore small. Good demand and none too abundant supplies, with the probable return of the speculative element, combine to make a bull market on vegetable oils. Why linseed oil should jump to $1.81 per gal. for spot goods is unaccountable, considering that England has on hand abundant supplies of this oil. With the harbor strike in full force, the naval stores market was in a strong position at the beginning of the week, but it weakened at the close when shipping conditions improved. There are no spot supplies of spirits of turpentine, although stocks of rosins are fair.

HEAVY CHEMICALS

Resulting from the recently noted scarcity of *sulphuric acid*, the 66 deg. variety is being held at higher figures in some quarters. Some dealers are holding it at $18 to $20 per ton in tank cars, whereas formerly it could be bought as low as $15 per ton. Manufacturers in the Middle West are said to be asking $22.50 per ton, f.o.b. works. Former quotations of $12 to $13 per ton on the 60 deg. are strictly maintained.

Sodium nitrite relaxed slightly during the past week and can now be bought around 13 to 14c. per lb., comparing with the previous quotation of 15 to 18c. *Sodium bichromate*, however, shows the opposite tendency and is firmer at an increase of ½c. over the minimum quotation of 12c. per lb. of last week.

Attributable to depleted supplies resulting from England's inability to make shipments is the higher minimum offering price of *caustic soda* by second hands of $3.30 per cwt. One sale of 600 tons at $1.85 per cwt. at works was reported. Several inquiries regarding contracts on this commodity and *soda ash* have been received, but manufacturers in the face of present conditions are in no hurry to take them up. A few small contracts for *sinc oxide, lithopone* and *sodium silicate* are the only ones reported as signed recently. Spot soda ash is in strong demand, and the dense is difficult to get at $2.25 per cwt. ex-store.

The continued scarcity has increased the minimum price of *aqua ammonia* another 1c. per lb., 9c. now being the lowest mark.

Sal ammoniac is going to be very scarce owing to the present shortage of ammonia and *muriatic acid*, the latter being in large request from color manufacturers. Manufacturers of sal ammoniac are usually able to meet English quotations on this chemical, but with jobbers at present quoting 11½c. per lb. for English goods, they are out of the market.

Although *sodium prussiate*, yellow, afloat from England is being offered at 24c. per lb., spot material holds unchanged at 26-27c.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, OCT. 15, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	......–......	$0.55 –$0.60
Acetone	lb.	$0.13½–$0.14	.15 – .15½
Acid, acetic, 28 per cent	cwt.	2.50 – 3.00	3.00 – 3.25
Acetic, 56 per cent	cwt.	5.00 – 5.50	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00 –12.50	12.90 –13.50
Boric, crystals	lb.	.13 – .13½	.13½– .14
Boric, powder	lb.	.13 – .13½	.13½– .14
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	1.50 – 1.75	2.00 – 2.50
Hydrofluoric, 52 deg.	lb.	.12 –......	.14 –......
Lactic, 44 per cent. tech	lb.	.11 – .14	.12 – .16
Lactic, 22 per cent. tech	lb.	.05 – .06	.05½– .07
Molybdic, C. P	lb.	......–......	4.00 – 4.25
Nitric, 40 deg.	lb.	.06 – .06½	.07 – .08½
Nitric, 42 deg.	lb.	.07 – .07½	.08 –......
Oxalic, crystals	lb.	.23 – .25	.25 – .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 –......	.10 – .14
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	......–......	2.30 – 2.60
Sulphuric, 60 deg., tank cars	ton	12.00 –16.00	......–......
Sulphuric, 60 deg., drums	ton	17.00 –......	22.00 –......
Sulphuric, 60 deg., carboys	ton	20.00 –......	25.00 –......
Sulphuric, 66 deg., tank cars	ton	17.00 –18.00	22.00 –23.00
Sulphuric, 66 deg., drums	ton	20.00 –21.00	25.00 –26.00
Sulphuric, 66 deg., carboys	ton	25.00 –......	30.00 –40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 –......	27.00 –......
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 –......	32.00 –......
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 –......	35.00 –......
Tannic, U. S. P.	lb.	......–......	1.35 – 1.45
Tannic (tech.)	lb.	....–......	.42 – .55
Tartaric, crystals	lb.	......–......	.74 – .77
Tungstic, per lb. of WO	lb.	......–......	1.20 – 1.40
Alcohol, Ethyl	gal.	4.80 –......	4.95 –......
Alcohol, Methyl	gal.	1.30 –......	1.33 – 1.38
Alcohol, denatured, 188 proof	gal.	.56 –......	.58 – .60
Alcohol, denatured, 190 proof	gal.	.52 –	54 – .56
Alum, ammonia lump	lb.	.03½– .04½	.04½– .04½
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½– .02	.02½– .02½
Aluminum sulphate, iron free	lb.	.02½– .03	.03½– .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08 –......	.08½– .08½
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	......–......	.30 – .35
Ammonium carbonate, powder	lb.	.13 – .13½	.14 – .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½– .13	.13½– .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 – .12½	.13 – .13½
Ammonium nitrate	lb.	.10 –......	.11 – .12
Ammonium sulphate	lb.	.05 –......	.06 –......
Amyl acetate	gal.	......–......	3.75 – 4.00
Arsenic, oxide, lumps (white arsenic)	lb.	......–......	.09 – .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	......–......	......–......
Barium chloride	ton	85.00 –......	90.00 –100.00
Barium dioxide (peroxide)	lb.	.22 –......	.24 –......
Barium nitrate	lb.	.10 – .10½	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.03½– .04
Bleaching powder (see calcium hypochlorite)		......–......	....–......
Blue Vitriol (see copper sulphate)		......–......	....–......
Borax (see sodium borate)		......–......	....–......
Brimstone (see sulphur, roll)		......–......	....–......
Bromine	lb.	......–......	.65 – .75
Calcium acetate	cwt.	2.00 – 2.05	2.10 –......
Calcium carbide	lb.	......–......	.04 – .05
Calcium chloride, fused, lump	ton	19.00 –25.00	30.00 –40.00
Calcium chloride, granulated	lb.	.01½– .01½	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	2.25 – 2.50	.... – 2.75
Calcium peroxide	lb.	......–......	1.50 – 1.70
Calcium phosphate, monobasic	lb.	......–......	.75 –......
Calcium sulphate, precipitated	lb.	......–......	.09 – .09½
Carbon bisulphide	lb.	.05½–	.06 – ....
Carbon tetrachloride, drums	lb.	.10 – .11...	.12 – .14
Carbonyl chloride (phosgene)	lb.	......–......	.75 –......
Caustic potash (see potassium hydroxide)		......–......	......–......
Caustic soda (see sodium hydroxide)		......–......	......–......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.08 –......
Cobalt oxide	lb.	......–......	1.50 – 1.55
Copperas (see iron sulphate)		......–......	......–......
Copper carbonate, green precipitate	lb.	......–......	.28 – .31
Copper cyanide	lb.	......–......	.65 – .70
Copper sulphate, crystals	lb.	.08½– .08½	.09 – .09½
Cream of tartar (see potassium bitartrate)		....	......–......
Epsom salt (see magnesium sulphate)		......–......	......–......
Formaldehyde, 40 per cent	lb.	......–......	.22½– .24
Glauber's salt (see sodium sulphate)		......–......	......– ....
Glycerine	lb.	......–......	.19 – .21
Iodine, resublimed	lb.	......–......	4.50 –......
Iron oxide, red	lb.	......–......	.03 – .20
Iron sulphate, (copperas)	cwt.	1.00 –......	1.20 – 1.50
Lead acetate, normal	lb.	....	.12½– .14½
Lead arsenate (paste)	lb.	......–......	.13 – .17
Lead nitrate, crystals	lb.	......–......	.85 – .86½
Litharge	lb.	......–......	.09½– .10½
Lithium Carbonate	lb.	......–......	1.50 –......
Magnesium carbonate, technical	lb.	......–......	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	2.00 – 2.63	2.75 – 3.00
Magnesium sulphate, commercial	100 lb.	1.75 –......	2.00 – 2.50
Nickel salt, double	lb.	.14 –......	.15 –......
Nickel salt, single	lb.	.12 –......	.15 – .16
Phosgene (see carbonyl chloride)		......–......	......–......
Phosphorus, red	lb.	......–......	.60 – .70
Phosphorus, yellow	lb.	......–......	.35 – .37
Potassium bichromate	lb.	.28 – .30	... – ....
Potassium bitartrate (cream of Tartar)	lb.	......–......	.55 – .60
Potassium bromide, granular	lb.	......–......	... – .60
Potassium carbonate, U S. P.	lb.	.60 –......	.65 – .70
Potassium carbonate, crude	lb.	.19 –......	.21 –......
Potassium chlorate, crystals	lb.	.20 – .24	.25 – .30
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.30 – .32	.35 – .40
Potassium iodide	lb.	......–......	3.55 – 3.60
Potassium nitrate	lb.	.19 –......	.21 –......
Potassium permanganate	lb.	......–......	.55 – .65
Potassium prussiate, red	lb.	......–......	1.05 – 1.15
Potassium prussiate, yellow	lb.	...... –......	.45 – .55
Potassium sulphate	ton	225.00 –......	......–......
Rochelle salts (see sodium potas. tartrate)		......–......	......–......
Salammoniac (see ammonium chloride)		......–......	......–......
Sal soda (see sodium carbonate)		......–......	......–......
Salt cake (sodium sulphate)	ton	17.00 –21.00	......–......
Silver cyanide	oz.	......–	1.19 –......
Silver nitrate	oz.	......–	.69½– .70½
Soda ash, light	100 lb.	1.90 –	2.00 – ....
Soda ash, dense	100 lb.	2.25 –......	2.50 – 2.75
Sodium acetate	lb.	.05½– .06½	.07 – .08
Sodium bicarbonate	100 lb.	2.35 –......	2.75 – 3.00
Sodium bichromate	lb.	.12 – .12½	.12½– .13
Sodium bisulphate (nitre cake)	ton	3.00 – 8.00	10.00 –......
Sodium bisulphite	cwt.	1.80 – 1.90	2.00 – 2.10
Sodium borate (borax)	lb.	.07½–......	.08 – .08½
Sodium carbonate (sal soda)	100 lb.	1.35 – 1.50	1.50 – 1.75
Sodium chlorate	lb.	.15 –......	.16 – .18½
Sodium cyanide	lb.	.30 –......	.31 – .34
Sodium fluoride	lb.	.14 –......	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	3.30 –3.40	3.45 – 3.50
Sodium molybdate	lb.	2.50 –......	3.25 –......
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.15 – .17	... – .18
Sodium peroxide, powdered	lb.	......–......	.30 – .32
Sodium phosphate, dibasic	lb.	.03½– .04	.04½– .05
Sodium potassium tartrate (Rochelle salts)	lb.	......–......	.43 – .45½
Sodium prussiate, yellow	lb.	.27 – ...	.27½– .28
Sodium silicate, solution (40 deg.)	lb.	.01½– .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½– .03	.03½– .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.15 – 1.25	1.50 – 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	......–......	.05 – .06
Sodium sulphite, crystals	lb.	.03½–......	.04 – .06
Strontium nitrate, crystals	lb.	.25 –......	.28 –......
Sulphur chloride	lb.	.05½–......	.06 –......
Sulphur, crude	ton	22.00 –......	......–......
Sulphur dioxide, liquid, cylinders	lb.	......–......	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.10 –......	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 –......	3.15 – 3.40
Tin bichloride (stannous)	lb.	.44 –......	.46 – .50
Tin oxide	lb.	......–......	.60 –......
Zinc carbonate, precipitate	lb.	......–......	.20 –......
Zinc chloride, gran.	lb.	.12½–......	.13½– .14
Zinc cyanide	lb.	.49 –......	.50 –......
Zinc dust	lb.	.09 – .11	.11 – .14
Zinc oxide, dry American	lb.	......–......	.09½– .09½
Zinc sulphate	lb.	.03½– .03½	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.32	—	.50
Aniline oil, drums extra	lb.	.32	—	.33
Aniline salts	lb.	.33	—	.36
Anthracine, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.00	—	1.15
Benzidine, base	lb.	1.00	—	1.25
Benzidine, sulphate	lb.	.90	—	1.15
Benzoic acid, U. S. P.	lb.	.90	—	1.10
Benzoate of soda, U. S. P.	lb.	.85	—	1.10
Benzol, pure, water-white, in drums (100 lb.)	gal.	.32	—	...
Benzol, 90%, in drums (100 lb.)	gal.	.24	—	.28
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	3.75	—	4.50
Beta naphthol, sublimed	lb.	.75	—	.80
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.85	—	.90
Cresylic acid, 95-97%, dark, in drums	gal.	.80	—	.85
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.40	—	2.25
Dimethylaniline	lb.	.55	—	.60
Dinitrobenzol	lb.	.26	—	.37
Dinitroclorbenzol	lb.	.25	—	.30
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.33	—	.36
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.65
Diphenylamine	lb.	.58	—	.75
H-acid	lb.	1.60	—	1.75
Metaphenylenediamine	lb.	1.15	—	1.80
Monochlorbenzol	lb.	.12	—	.15
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.06½	—	.07½
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	.75	—	1.25
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.35	—	.45
Nitro-toluol	lb.	.27	—	.20
Ortho-amidophenol	lb.	3.00	—	4.25
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.90	—	1.25
Ortho-nitro-toluol	lb.	.25	—	.40
Ortho-toluidine	lb.	.25	—	.45
Para-amidophenol, base	lb.	2.50	—	3.50
Para-amidophenol, HCl	lb.	2.50	—	3.25
Para-dichlor-benzol	lb.	.15	—	.18
Paranitraniline	lb.	.95	—	1.10
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.50	—	4.00
Paratoluidine	lb.	1.50	—	2.50
Phthalic anhydride	lb.	1.50	—	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.16	—	.17
Pyridin	gal.	2.50	—	.....
Resorcin, technical	lb.	3.50	—	3.75
Resorcin, pure	lb.	6.50	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.37	—	.45
Salicylic acid, U. S. P.	lb.	.45	—	.50
Salol	lb.	.90	—	.95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.20	—	.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.18	—	.24
Sulphanilic acid, crude	lb.	25	—	.30

Tolidine	lb.	$1.70	—	$2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	27	—	.....
Toluol, in drums	gal.	.28	—	.30
Xylidine, drums, 100 gal	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal	gal.	.23	—	.27
Xylol, commercial, in tank cars	gal.	.22	—	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.41	—	$0.43
Beeswax, refined, yellow	lb.	46	—	.48
Beeswax, white pure	lb.	.63	—	.65
Carnauba, No. 1	lb.	.84	—	.86
Carnauba, No. 2, regular	lb.	.75	—	.78
Carnauba, No. 3, North Country	lb.	.46	—	.47
Japan	lb.	.20	—	.21
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	...
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.06½	—	.07
Paraffine waxes, refined, 118-120 m.p.	lb.	.08½	—	.09
Paraffine waxes, refined, 128-130 m.p.	lb	.09½	—	.09½
Paraffine waxes, refined, 133-135 m.p.	lb.	.11	—	.11½
Paraffine waxes, refined, 135-137 m.p.	lb.	.12	—	.13½
Stearic acid, single pressed	lb.	.23	—	.26
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.25
Pine oil, pure, dest. dist	gal.	1.05
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.80
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.47
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref	gal.	.51

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$17.65	—	$18.25
Rosin E-I	280 lb.	17.75	—	19.50
Rosin K-N	280 lb.	20.00	—	22.25
Rosin W. G.-W. W	280 lb.	22.50	—	24.00
Wood rosin, bbl	280 lb.	17.00	—	17.50
Spirits of turpentine	gal.	1.65	—	....
Wood turpentine, steam dist	gal.	1.61	—	....
Wood turpentine, dest. dist	gal.	1.50	—	....
Pine tar pitch, bbl	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	14.75
Retort tar, bbl	280 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.95	—	1.12
Rosin oil, fourth run	gal.	1.05	—	1.15

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.49½	—	$0.49½
Upriver coarse	lb.	.34½	—	.35½
Upriver caucho ball	lb.	.34½	—	.35½
Plantation—First latex crepe	lb.	.52	—	.53½
Ribbed smoked sheets	lb.	.51½	—	.52½
Brown crepe, thin, clean	lb.	.46½	—	.47½
Amber crepe No. 1	lb.	.50	—	.51

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.18½	—	$0.19
Castor oil, AA, in bbls	lb.	.21½	—	.22
China wood oil, in bbls	lb.	.22½	—	.23
Cocoanut oil, Ceylon grade, in bbls	lb.	.17½	—	.18½
Cocoanut oil, Cochin grade, in bbls	lb.	.19½	—	.20
Corn oil, crude, in bbls	lb.	....	—	.21½
Cottonseed oil, crude (f.o.b. mill)	lb.	....	—	.19
Cottonseed oil, summer yellow	lb.	.23½	—	.24
Cottonseed oil, winter yellow	lb.	.24½	—	.25
Linseed oil, raw, car lots	gal.	1.80	—	1.87
Linseed oil, raw, tank cars	gal.	1.72	—	....
Linseed oil, boiled, car lots	gal.	1.82	—	....
Olive oil, commercial	gal.	2.50	—	2.80
Palm, Lagos	lb.	.17	—	.17½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16	—	.18
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.23½	—	.23½
Peanut oil, refined, in bbls	lb.	.27	—	.28
Rapeseed oil, refined in bbls	gal.	1.45	—	1.50
Rapeseed oil, blown, in bbls	gal.	1.60	—	....
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.17½	—	.18½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½	—	.15½

FISH

Winter pressed Menhaden	gal.	$1.20	—	.....
Yellow bleached Menhaden	gal.	1.23	—	....
White bleached Menhaden	gal.	1.25	—	.....
Blown Menhaden	gal.	1.30	—	....

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	47.50	—	50.00
Casein	lb	.16	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb	.04½	—	.06
Chalk, English, dense	lb.	$ .04	—	$ .05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	13.50	—	17.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	30.00	—	35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	1.10	—	1.15
Shellac, D. C	lb.	.....	—	....
Shellac, V. S. O	lb.	.....	—	....
Shellac, Diamond I	lb.	.....	—	....
Shellac, orange, fine	lb.	1.25	—	.....
Shellac, orange, superfine	lb.	1.20	—	1.30
Shellac, A.C. garnet	lb.	1.10	—	.....
Shellac, bleached, bone dry	lb.	1.35	—	.....
Shellac, bleached, fresh ground	lb.	1.10	—	1.15
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	1,000	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.25	—	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70	—	.....
Ferro-manganese, 70-80% Mn	gross ton	110.00	—	115.00
Spiegeleisen, 16-20% Mn	gross ton	33.00	—	36.00
Ferro-molydenum, per lb. of Mo	lb.	3.00	—	3.50
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, $C_2.O_3$	unit	$0.60	—	$0.80
Chrome ore, 48% and over	unit	1.00	—	1.25
Coke, foundry, f.o.b. ovens	net ton	7.00	—	7.50
Coke, furnace, f.o.b. ovens	net ton	6.00	—	6.50
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines	net ton	.....	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.80
Lump lime, common, including container 300	bbl.	2.65
Common brick, at dock	M.	16.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	50.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	40.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	1.75
Linseed oil, 5 gal. cans	gal.	1.90
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

NOTE—These items were compiled as of Dec. 5, but appear in this issue due to the delay in publication due to the printers' strike.

District of Columbia

WASHINGTON—The Bureau of Standards will soon award the contract for furnishing material and constructing 8 chemical laboratory tables complete with superstructure, drain boards, and peg racks, and 2 of same without superstructure, drain boards and peg racks, and 10 maple top tables, 7 ft. long, 30 in. wide, and 1¾ in. thick.

Florida

MURDOCK—W. S. Wilson, Dothan, Ala., has purchased a large acreage of timber land near here, and plans to construct a turpentine distillery on same.

Iowa

WINFIELD—The city will receive bids early in January for the construction of sewers and a sewage disposal plant. Estimated cost, $100,000. H. R. Green, 101 West 2nd St., Cedar Rapids, engineer.

Maryland

CURTIS BAY (Baltimore P.O.)—The Standard Wholesale Phosphate Co., 1214 Continental Bldg., has awarded the contract for the construction of a 1-story 60 x 216 x 320-ft. acid phosphate plant on Aspin St., to the Whiting-Turner Construction Co., Stewart Bldg., Baltimore. Estimated cost, $72,000.

Michigan

DETROIT—The General Carbon Co., 542 5th Ave., New York City, has awarded the contract for the construction of a 1-story, 100 x 120 ft. manufacturing plant, a 1-story. 40 x 50 ft. boiler house and a 1-story, 25 x 30-ft. garage, to the Austin Co., 217 Broadway, New York City. Estimated cost, $75,000.

North Dakota

WILLISTON—The city plans to install a new filter bed and make alterations in present waterworks plant. Miss Jack, city engineer.

Ohio

CLEVELAND—A. A. Chilcote Co. has purchased a site on East 21st St. and Superior Ave., and plans to construct a 2-story photographers commercial building on same. Estimated cost, $100,000. A. A. Chilcote, 733 Prospect Ave., president.

CLEVELAND—The Middle States Rubber Co., recently incorporated, plans to construct a large factory for the manufacture of tires, tubes and other rubber articles, in this vicinity. James L. Lind, Municipal Court, and E. Ewing, 3206 West 98th St., interested.

HIRAM—Hiram College plans a campaign to obtain funds to construct a 4-story men's dormitory and science building. Estimated cost, $600,000. F. A. Henry, 405 Sloan Bldg., Cleveland, manager in charge. Abram Garfield, National City Bank Bldg., Cleveland, engineer.

Oklahoma

OKLAHOMA CITY—The State Board of Health has ordered the city to install a sewage disposal plant. Estimated cost, $1,000,000.

New Jersey

JERSEY CITY—The city will soon award the contract for the furnishing and delivering of hypochlorite of lime and liquid chlorine for a period of 12 months for the treatment of Jersey City water supply at Boonton.

Texas

PLAINVIEW—The City Council will soon award the contract for the construction of a sewage treatment plant, consisting of Imhoff tank and sprinkling filters. filter material, etc., J. F. Frye, secretary.

Washington

SEATTLE—F. A. Narramore, architect, Central Bldg., will soon receive bids for the construction of a 3-story, 250 x 250-ft. factory on 8th and Dexter Sts., for the manufacture of school furniture, laboratory equipment, etc. for the School Board. Estimated cost, $160,000.

Wisconsin

MADISON—The Madison Kipp Lubricating Co., Waubesa St., has awarded the contract for the construction of a 52 x 240-ft. addition to its present shop, to George C. Cnare & Son, 2000 Jenifer St. Estimated cost, $200,000.

British Columbia

SQUAMISH—R. Hudson, Everett, Wash., is conducting preliminary negotiations with a view to constructing a pulp mill at the terminus of the Pacific Great Eastern Railway, near here, for the American Syndicate. Estimated cost, $1,000,000. John Callaghan, Vancouver, engineer.

Ontario

BOSTON CREEK—The Miller Independent Mines, Ltd., plans to construct a 100-ton mill, also install a new electrical plant, in connection with its gold mine here. C. A. Miller, superintendent.

PORT CREDIT—The St. Laurence Starch Co. has awarded the contract for the construction of a 4-story, 60 x 150-ft. building, to Wells & Gray, Confederation Life Bldg., Toronto. Estimated cost, $90,000.

Industrial Notes

The Foundation Oven Corporation is a new concern specializing in the "American" coke-oven, lignite-oven, carbonization process, recovery system, and coal products refining system. Its literature announces a complete chemical engineering service from test tube to finished plant. This is made possible through the association of the Foundation Oven Corp. with the Foundation Co. and the Foundation Research Laboratories, Inc. F. E. Breithut, lately major in the Chemical Warfare Service, is associated with the Foundation Oven Corp., with headquarters in the Woolworth Bldg., New York City.

The Metals Production Co., Chicopee, Mass., will pay creditors a first dividend of 10 per cent on all claims which have been approved and allowed and are not entitled to priority. The trustee has been ordered to pay in full all claims which have been approved and allowed and are entitled to priority. The dividend is payable immediately by Trustee Harry C. Dodge, Boston, Mass.

The Garred-Cavers Corp. has made contracts and issued licenses for the use of the Garred-Cavers process at the smelters of the following companies: The International Nickel Co. of Canada, Ltd., the Tennessee Copper Co. and the Cerro de Pasco Copper Corp.

The Driver-Harris Co., Harrison, N. J., is now selling its wire rope products direct to the trade instead of through its former selling agents. These products include sash cord and tiller rope in plain iron, galvanized iron, phosphor bronze, special bronze, monel metal, and all special grades. In addition to this, the company has increased its facilities to include all grades of rope in 6 x 7, 6 x 12, and 6 x 19 construction, such as drilling cable, elevator rope, haulage rope, sand lines, etc., in all sizes up to ¾ in. The other products of the company are resistance materials of nickel alloys in the form of wire, strip and sheet for electric heating controllers, rheostats and resistance elements, wire for spark plugs and weaving, rods and sheets of pure nickel and its alloys; cold rolled strip steel; nichrome castings such as annealing boxes, carbonizing boxes, pots, tubes, rotary and stationary retorts, dipping baskets, pyrometer protection tubes, etc.; flexible heater cord and thermostrip.

The Electric Furnace Co., Alliance, Ohio, recently shipped to the Dayton Engineering Laboratories, Dayton, Ohio, an electric furnace for melting and refining aluminum in the Delco plant. This furnace has a hearth capacity of 500 lb, and a melting rate of 200 lb. of aluminum per hr. It is equipped with a double charging door in the front and rear, and otherwise is similar to the standard Baily electric furnace of 105-kw. electrical capacity, and 1500-lb. hearth capacity, that is used for melting brass.

The Ingersoll-Rand Co., New York, N. Y., has established a branch office in the Sam Houston Life Bldg., Dallas, Texas, the better to serve the Texas and Oklahoma territory. The office will be in charge of Mr. R. H. Brown, Jr.

The Booth Electric Furnace Co. was organized in Chicago during the latter part of September with a paid-up capital of $1,000,000, one-half preferred stock and one-half common. This company was formed to take over all patents, assets and good will of the Booth-Hall Co., manufacturer of electric steel and brass melting furnaces. The new company has also taken over the business of the former company and proposes to develop the electric furnace business along standard manufacturing lines. It is now prepared to deliver furnaces in four sizes, 250-lb., 500-lb., 1000-lb. and 2000-lb. equipments. The two-phase two-electrode Booth-Hall furnace will be made in five sizes, i.e., ½-ton, 1½-ton, 3-ton, 6-ton and 12-ton, and an improved type of oval furnace is also being designed. Associated in the management of the company will be a number of engineering and operating executives in the public service field. Mr. L. E. Myers, of Chicago, president of the L. E. Myers Co., has been elected president of the new corporation; Mr. C. H. Booth, formerly president of the Booth-Hall Co., vice-president; Mr. W. K. Booth, formerly chief engineer of the Booth-Hall Co., secretary; and Mr. L. J. Clark, of the L. E. Myers Co., treasurer. In addition to the president, vice-president and secretary, the board of directors will include Mr. Martin J. Insull, vice-president of the Middle West Utilities Co., and Mr. E. W. Lloyd, of the Commonwealth Edison Co., both of Chicago.

The Carborundum Company announces the opening of branch offices and warehouse in Detroit, Mich., in the Burkhardt Bldg., at Second and Larned Sts., under the direction of Mr. Anthony Dobson, who will have charge of the Detroit sales district. The new offices and the warehouse are opened with a view to giving quicker and better service to the users of carborundum products in the Detroit district, and to that end a complete stock of carborundum and aloxite grinding wheels, carborundum and aloxite paper and cloth and other carborundum products will be carried.

The St. Louis Coke & Chemical Co. has disposed of $5,000,000 of 8 per cent cumulative preferred stock to the Studebaker Bros. Trust Co. of Chicago and the Mississippi Valley Trust Co. of St. Louis. The proceeds of the sale will be used for the construction of a new coke-oven and blast-furnace plant now being erected at Granite City, Ill. The entire output of hot metal, gas and tar has been contracted for a period of years to the National Enameling & Stamping Co.

Huntington, Heberlein & Co., Ltd., announces that the entire capital stock of the corporation has been acquired by Messrs. Henry Gardner & Co., Ltd., and that the business offices of the former will be transferred to the registered offices of the latter at 2, Metal Exchange Buildings, London, E. C. 3. The board of Huntington, Heberlein & Co., Ltd., will consist of Walter Gardner, chairman and managing director; H. C. Bingham, H. J. Bush and R. H. Bingham.

The Armstrong Bureau of Related Industries, 11 South LaSalle St., Chicago, is a new institution, the first of its kind, founded on the principles that American business can reach its highest development and perform its greatest service to the commonwealth only through modern, co-operative methods. It renders a professional service by which competitive businesses attain maximum results through co-operation in organization, marketing and production. Mr. John Walsh, acting and chief counsel for the Federal Trade

Commission from its inception to April, 1919, has identified himself with this organization and will furnish his exclusive services to it on all matters pertaining to business and industrial co-operation. Mr. Walsh maintains headquarters in Washington, D. C.

M. Ferraris & Co., agents of the American Steel Export Co. for Italy, state that the continued activity and development of Italy as a field for American machinery, equipment, steel and metal products have caused them to send Mr. Joel B. Ives of the engineering and contracting department of the Export Company to Italy to confer with the Italian agents as to means of dealing adequately with the situation and insuring the continuance of effective sales service in that territory.

The Standard Chemical Co. of Toronto, the stock of which is largely held in England, has elected to the presidency David Gilmour, an eminent Scottish engineer of wide experience.

The Electric Furnace Construction Co., Philadelphia, Pa., advises orders received for Greaves-Etchells electric furnaces from Lacheze et Fils, Dijon; and C. Markham & Co., Ltd., Chesterfield.

The Westinghouse Electric & Mfg. Co. has announced the award of its four annual War Memorial Scholarships of $500 each. The following are the men who received the awards, the courses chosen and the schools at which their studies will be conducted: Herbert S. Pahren, Cincinnati, Ohio, technical engineering course at the Univ. of Wisconsin; Arthur Martens of East Pittsburgh, Pa., electrical engineering at the Carnegie Institute of Technology; Paul O. Langguth, East Pittsburgh, electrical engineering at the University of Pittsburgh; Andrew P. Lesniak, East Pittsburgh, mechanical engineering at the University of Pittsburgh. Each scholarship carries with it an annual payment of $500 for a period not to exceed four years, the payment to be applied toward an engineering education in any technical school of college selected by the successful candidate with the approval of the scholarship committee. These scholarships have been established as a memorial to those employees of the company and its subsidiaries who entered the service of their country during the war. Four awards will be made each year, so that after three years this company will be maintaining sixteen of these scholarships in the best technical schools of the United States.

The Chicago Pneumatic Tool Co. announces that on Oct. 1 its Birmingham office was removed from 801 Brown Marx Bldg., to 1925 Fifth Ave. North, where a service station with a complete stock of pneumatic tools, electric tools, air compressors, oil engines, rock drills and repair parts is maintained. This company also announces that Mr. C. W. Cross has been appointed manager of Western railroad sales with headquarters at the Fisher Bldg., Chicago.

Manufacturers' Catalogs

The Schutte & Koerting Co., Philadelphia, desires to announce that it has issued a revised 8-B catalog on Stop, Stop Check and Emergency Valves, and will be pleased to forward a copy to those interested and inquiring for same.

The Goulds Mfg. Co., Seneca Falls, N. Y., has published a bulletin entitled "Centrifugal Pump Sales Service Data." This was originally issued as a series of sales letters for its own organization, but owing to the demand from outside sources, the company decided to publish them in bulletin form and will be glad to send one on request. The bulletin contains information on theory, designs, testing, etc., of centrifugal pumps.

The Barber-Greene Co., Aurora, Ill., announces a new catalog showing the latest B-G standardized material handling machines, standardized belt conveyor (portable and stationary) and self-feeding bucket loaders. Copies will be sent upon request.

The Tolhurst Machine Works, Troy, N. Y.: Catalog 8 is a new and attractive catalog on its centrifugals (hydro-extractors), which are illustrated and described.

The Gutton & Cumfer Mfg. Co., Chicago, Ill., calls attention to Bull. No. 191 on steam jacketed pumps and steam jacketed pipe fittings.

The Cleveland Instrument Co., Cleveland, Ohio: "Cleveland Resistance Pyrometers" is the title of Bull. No. 40, just issued.

The Koppers Company, Pittsburgh, Pa., has issued attractive 68-page catalog illustrating and describing by-product coke and gas plants, benzol recovery plants, motor fuel recovery plants, tar distilling plants and ammonia recovery apparatus.

The Quigley Furnace Specialties Co., New York City: "Carbosand" is the title of a new booklet, just issued, describing a refractory granular material for making rammed-in linings, special tile patches and repairs in furnace structures. Another bulletin is "Hytempite in the Foundry," which describes the use of this high temperature cement in the various phases of foundry practice, taking up in sequence its applications in the iron foundry, steel foundry, brass foundry and malleable foundry.

The Lea-Courtenay Co., Newark, N. J., has recently issued two new bulletins: One, termed H-4, is a veritable treatise on centrifugal pumps as well as a catalog of its most complete line; the other, Bull. S-5, gives a synopsis of typical centrifugal pumps installed in various industries, showing the range of pumping service which its centrifugal pumps cover. Copies will be sent upon application.

The Milliken Bros. Mfg. Co., Inc., New York City, is distributing catalogs Nos. 10 and 11, descriptive of Milliken buildings. "Choice of a Thousand Buildings" is the title of Catalog No. 10, which illustrates and describes its buildings constructed by the standardized truss unit system, designed to facilitate transportation by rail or water or on animal back; to minimize the use of labor and tools in erection; and to meet a wide range of industrial service. Catalog No. 11, entitled "Erection Handbook," is a supplement to Catalog No. 10, and illustrates and describes in a comprehensive way all construction details necessary to make the proper foundations, and to erect any type of building selected, so that construction can be started just as soon as the material is received.

The New Jersey Zinc Co., New York: Five new booklets have been issued by this company, entitled "Chemicals," "Roller Zinc," "Zinc Dust," "Pigments" and "Metals."

The Metal & Thermit Corp., New York City, has issued a folder entitled "How Thermit Cured My Diseased Neck," which illustrates a thermit welding repair, consisting of building up with thermit steel the worn pods on the end of a 16-in. dia. neck of a large roughing mill pinion.

The W. S. Rockwell Co., New York, will gladly send to anyone interested its new steel heat-treatment chart.

The Bailey Meter Co. is distributing Bull. No. 30, entitled "Fluid Meters for Low-Pressure Gas and Air."

The Electric Furnace Co., Alliance, Ohio, calls attention to three new booklets just received from the printer. Booklet 7-B deals with electric furnaces for melting brass; Booklet 17-B describes a special furnace for rolling mills which is designed for pouring the metal directly into the molds; Booklet 13-B is a discussion of the various electric non-ferrous metal melting furnaces, which is a reprint of the paper delivered by T. F. Baily before the American Institute of Chemical Engineering, Boston, Mass., at the June, 1919, meeting.

Sarco Company, Inc., New York City: "Steam Trap Sarco" is the title of a new four-page booklet just issued.

The Star Brass Works, Chicago, Ill., has just issued a 24-page bulletin, No. 5, covering atomizing and spray nozzles for special applications. This literature deals with the application of spray nozzles for all industrial purposes, also engineering data involved in same. Copies will be sent upon request.

The Combustion Engineering Corporation, New York City, calls attention to its latest catalog on Grive Grates, which illustrates and describes the detail and operation of the grate. This attractive catalog will be sent upon request to anyone interested in burning a wide range of fuels under hand-fired conditions, with a high degree of economy.

The Bicycle Manufacturers' Association, Hartford, Conn., has published a booklet entitled "Industrial Transportation." This booklet calls attention to industrial concerns as to the advantage of a bicycle as a method of transportation for its employees.

The Petroleum Iron Works Co., Sharon, Pa., has issued a catalog of steel barrels and drums. This attractive catalog illustrates and describes in 28 pages the economic value of steel shipping containers, the "G-E-M" bilged steel barrels, the barrel with the hoop formation; "Presteel" I. C. C. drums; "Presteel" light gage shipping drums, and "P. I. W." storage tanks, together with authoritative information relative to its manufacture, advantages, use and general specifications.

The Wellman-Seaver-Morgan Co. desires to announce Bull. No. 27, which describes the automatic ore unloaders on the Great Lakes. Copies will be sent upon request.

The Foxboro Co., Inc., Foxboro, Mass.: Bull. No. 194-1, entitled "Foxboro Thermometers," is a complete treatise on the subject of temperature measuring instruments, which states that any temperature between the ranges of minus 60 to 1000 deg. F. can be measured accurately by these instruments. Special attention is called to pages 62 to 68, which show indicating thermometers with an improved style of dial, laid out from a scientific viewpoint to obtain the maximum visibility, and can be read without difficulty as far as 15 to 20 ft. Copies will gladly be sent upon request.

The Telzit Slide Rule Co., Chicago, Ill., has issued a booklet on the "Telzit" slide rule for instantly determining in advance the exact dimensions of coming cuts or for use in drawing or layout enlargement.

Bowser & Co., Fort Wayne, Ind., has issued a little folder which illustrates and describes a Bowser battery storage system for lubricating oil. The folder can be arranged to show one outfit, two outfits, three outfits or a battery of four tanks so that the prospect may understand that he can buy as many units as he requires, and the folder shows him how the units of any various capacities line up in uniform manner.

The Oliver Continuous Filter Co., San Francisco, Calif., has issued Bull. No. 12 on the construction, use and operation of the Oliver continuous filter and accessories. Illustrations showing apparatus under construction, in transit, and in actual plant operation are included, with information on the various sizes manufactured, the diversified products handled on the Oliver, and approximate capacities based on plant operations. The operation of the Oliver is fully covered, and the various adaptations of filter cloth, washing arrangements, etc., are completely explained. The Oliver sand table filter, for handling coarse and fast-settling materials, is also described and illustrated. Copies may be obtained upon application.

The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.: Circular 1563, "Railway Converter Substations," is a compilation of ideas of operating engineers' experience in substation work, and data in connection with the Westinghouse standards and practices adopted after years of experience.

The American Ore Reclamation Co., New York City, has issued a booklet on "Sintering and Desulphurizing of Iron Ore Materials."

The Blaw-Knox Co., Pittsburgh, Pa.: Bull. No. 202, covering Knox water-cooled appliances for glass furnaces; Bull. 200, entitled "Blaw Cableways"; Bull. No. 293, Blawforms for light walls and foundations; "The Blaw System for Building Construction" is the title of Catalog No. 18. Any or all of these publications will be sent upon request.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis.: C-H space heaters are illustrated and described in a new 4-page pamphlet, No. 479, entitled "Miscellaneous Applications of Electrical Heat"; C-H Rectangular Magnets" is the title of Booklet J, which illustrates and describes various types of apparatus; "C-H Drum Controllers" is the title of a new 4-page folder on this subject; C-H mine duty apparatus is illustrated and described in a new 8-page booklet which makes special reference to the mine duty apparatus installed in the plant of the St. Louis Smelting & Refining Co., St. Francois, Mo.

The Allis-Chalmers Mfg. Co., Milwaukee, Wis.: A booklet entitled "Prospectus of Apprenticeship System," which is for a young boy who shows talent along mechanical lines, offers an opportunity for him to become a first-class mechanic; Bull. No. 1432-C, on "Stamp Mills"; Bull. 1433, on "Allis-Chalmers Prospecting Mill for Free Gold Ores"; Bull. 1456, "Fairmont Type Crusher"; Bull. 1537, "Details of Allis-Chalmers Oil Engines," Diesel-type for ordering repairs and spare parts; "Centrifugal Pumps and Centrifugal Pumping Units" is the title of Bull. 1632-C, which illustrates large- and small-size centrifugal pumping units.

Published December 18th, With Current News

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
WALLACE SAVAGE
Assistant Editor

ALAN G. WIKOFF
Assistant Editor
L. W. CHAPMAN
Western Editor
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, November 26—December 3, 1919 *Number* 13

Approaching Normal Publication Dates

LOOKING back through the pile of letters of encouragement which arrived during the time when publication of CHEMICAL & METALLURGICAL ENGINEERING was suspended certainly impresses us with the idea that the thinking public is sick and tired of strikes to extinction, and has little sympathy indeed for the bludgeoning attitude lately so much in evidence. As an instance:

> Not that you need, but that it may aid in sustaining your moral position, I, a subscriber, state I am in sympathy with your action.
>
> You are justified in any reasonable expedient to meet the conditions imposed upon you, and would be sustained by men like me if you asked extra financial support (if you are overtaxed) or a reduction in service pending the solution of this dilemma.

Unfortunately it was physically impossible with the whole local industry paralyzed to continue the service as we wished and worked for; however, we feel we are getting rapidly out in the open. Double editorial sections will correctly complete the volumes without an undue tax on either subscriber or advertiser. Complying with postal regulations is rather a difficult task, but even a casual reader can see that these issues are timely in all respects except the date line.

Importance of Data On Small Volume Changes

ALTHOUGH numerous investigators have been making measurements of thermal expansion ever since LAVOISIER and LAPLACE began fairly accurate work of this character more than 135 years ago, the field to be covered has been scratched only at a few points. For instance, the total data on linear and cubic expansion of solids recorded in the 1916 edition of the Smithsonian Physical Tables occupy only two and one-half octavo pages, and most of the values given are derived from measurements of great antiquity. In the elaborate collection of physical constants issued by the French Physical Society in 1913, LE CHATELIER begins the section devoted to metallic alloys with the statement: "It is impossible to find numerical information concerning the physical properties of alloys which is worthy of any confidence."

A detailed description of A. W. GRAY'S very convenient dilatometer should therefore serve to impress many experimentors with the fact that it is comparatively easy to determine such missing but important data with great precision. Its many applications to the field of structural engineering and machine design do not need to be enlarged upon.

For pure metallurgical research, however, the method is worthy of careful consideration. Thus, dimensional changes during transition can be made the basis of a dilatometric method of thermal analysis which may reveal important new information. A knowledge of the magnitude of these changes is of particular importance when the materials have to be carried through such a region in the course either of their manufacture or of their ordinary use. Such knowledge would, for example, aid in determining the safe rate for heating or cooling large metal ingots.

The dilatometer can be made to throw light upon structural changes which take place at constant temperatures. As an instance, season cracking in bronzes, which has caused so much trouble in the water-supply equipment of New York City and in other cases, appears to be due in part to the action of differential expansions starting minute cracks which are greatly increased by the combined action of dimensional changes and corrosion.

More About American Dyes

PROTECTION against insidious German competition in dyes and allied chemicals is again urged by the President in his message to Congress, just convened. Quoting from his last message urging such legislation, he says:

"Among the industries to which special consideration should be given is that of the manufacture of dyestuffs and related chemicals. Our complete dependence upon German supplies before the war made the interruption of trade a cause of exceptional economic disturbance. The close relation between the manufacturer of dyestuffs, on the one hand, and of explosives and poisonous gases on the other, moreover, has given the industry an exceptional significance and value.

"Although the United States will gladly and unhesitatingly join in the program of international disarmament it will, nevertheless, be a policy of obvious prudence to make certain of the successful maintenance of many strong and well-equipped chemical plants. The German chemical industry, with which we will be brought into competition, was and may well be again a thoroughly knit monopoly capable of exercising a competition of a peculiarly insidious and dangerous kind."

But we fear the public as well as the Congressional mind has become rather confused by the many extraneous factors which have been introduced into the discussion. It is not a problem of foreign exchange, nor yet of the welfare of the men who have engaged in the manufacture of dyes in this country. The real problem is that of a vast German trust against what is still an infant industry. They can still make four times as many dyes in Germany as are made here. And they are going to make Americans sweat for what they sell. The German choice in the matter would be to make the American makers of dyes suffer, rather than the users. They want this market, more particularly because other countries have either adopted the license system, and thus closed the Germans out, or they are in the process of doing so. Each nation wants national independence in dyes.

Now the merit of national independence in dyes is that it provides for an academic army of chemists organized to work in the organic field, and prepared to make explosives, gases, and the many unexpected products needed in war. If we want such a body of men for the same reasons that England, France, Italy and Japan do, we must have the industry. We cannot have the men without the industry.

It is not a controversial subject between textile men and chemical manufacturers. Whatever happens, textile manufacturers will have to pay, and pay well, for their dyes. It is only a matter of time whether we let the German products in or keep them out. If we let them in they will be cheaper only until the American industry is extinguished, after which, of course, the Germans will be able to charge their own prices. The real question involved is not whether one industry or another makes more or less profit, or whether the American dye manufacturers incur heavy losses. The question is, Do we want the comprehensive preparation for war that can be obtained only by the active support of the dye chemist? If we do, there is but one way, and that is to exclude imports by a license system. A higher tariff alone will not do it.

A Thought on Labor's Goal

AT ONE of the critical periods of the war the British Minister of Education, ALFRED HENDERSON, who was also general secretary of the Labor Party, became convinced that the way to achieve peace was by negotiation with the German authorities. As this was not in accord with the policy of the Allies, his resignation as a member of the Cabinet was accepted. While to the British Government the change in personnel involved in his retirement was but an incident in the day's work, HENDERSON took it as a personal affront. He held that he was persecuted for his honest convictions, and he made his appeal to Labor for peace by negotiation while the Germans still occupied Belgium and northern France. So strong was this argument in regard to the invulnerability of the Hindenburg line and the uselessness of continued struggle that Labor was disposed to follow him, and the production of munitions in England straightway fell off in increasing ratio. To offset this a number of American labor leaders were invited to visit England and other allied countries, to carry to the workers of those lands the doctrine held in America by both capital and labor—that the only way to end the war was to win it. The mission was successful.

The following conversation has been reported to us, between one of the American leaders and a French professor of law at the Sorbonne whose philosophy of politics is of a socialistic turn:

"What," asked the professor of the American, "is the goal of organized labor in your country?"

"I do not know," was the reply.

"Then you are bound to fail. You cannot make progress if you do not know what you want."

"Possibly," conceded the American, "but I cannot reach the conclusion that we should do better with a specific program. We have in our country a very able instrument called the Constitution. It was drawn by a body of men of consummate ability and lofty character. Speaking for myself and my associates in the organization of labor in the United States, we are not to be compared with them in ability or vision. But not one of those men had ever seen a railway, or a steamboat, or a line of telegraph wire. News and goods were carried by the wind at sea, and by horses and mules on land. Machinery of the modern type and industrial life as we know it today were undreamed of by them. Therefore it occasionally happens that important and needed legislation is forbidden by the letter of some article of the Constitution that was designed for entirely different conditions. Then the pundits of the law are driven to the most remarkable talmudic twistings of the Constitution to make necessary legislation possible. Sometimes they cannot do this, and then long delays involving injustice and suffering ensue.

"Now, we have ideals of physical welfare and of intellectual standards that we hope to see labor realize, but these are neither definite nor fixed. We feel that we do not know enough to legislate for the men and women who will toil fifty or a hundred years from now. We push ahead where we can, and sometimes we make mistakes. Sometimes mistakes are made, in spite of our efforts to prevent them. But we do not want to make our errors permanent. It seems better, on the whole, to trust to the future, and to the intelligence of those who are to come after us, rather than to guess blindly, and to run the risk of guessing wrong."

We should like to hear more of such talk, and hope the time may soon be at hand when this quality of frankness will be the habit in general discussion. There is not sufficient confidence to warrant it yet, and we believe there are too many undeveloped and immature minds engaged in the councils of labor to permit to their leaders that freedom of speech that wholesome discussion demands. The same may be said of many groups of employers of labor. They have "put over" too many tricks in the past to have won the confidence of their employees.

There isn't any egg-of-Columbus solution to the labor situation. It must be based on confidence, and there isn't enough of it. Traditions are bad on both sides. In the big shake-up that the world has undergone a great deal has come up from the bottom that is far from admirable. There are many loud voices heard with neither character nor understanding back of them. Now, character is essential. The German Government got along for many years without it and seemed to prosper, but it didn't last. Character is social protein, and we must have it if we would endure. A great many labor unions have not yet learned that an agreement is an obligation, and it will be a long time before some of them do learn it. They will have to be made up of a more intelligent membership, a membership than can figure on consequences, before this can be expected. But collective bargaining by men of character and intelligence will come about if we have a great deal of faith and patience in spite of many disappointments. With the present growth of a sense of obligation among employers we believe it will soon spread among employees; and when that comes about we may look for sudden rises in efficiency curves.

Steel Prices And Service

ONE may regard it as simply an incident following the war-time control of steel prices that there has been so little fluctuation in the steel market in the past twelvemonth, but there is probably a permanent influence at work, one that makes "service" count in the competition. There must be competition of one description or another. It was competition made the American Navy what it is, competition between men, gunner's crews and vessels. There is some competition that is not advantageous. When railroads were debarred from cutting passenger rates they indulged in wasteful competition as to the convenience of service, whereby many railroads lost money on their passenger service and operated more trains than were needed to accommodate the public.

Competition in steel service may be popularly described as "all to the good." Fitting the steel to the particular employment intended by the customer makes for progress, as consumption is encouraged, and the seller, having found a steel that meets the requirement of a certain consumer, is in position to offer the same class of steel to another consumer who he knows has the same problem.

Service in steel means much more than furnishing steel of the particular character desired. It involves regular delivery as well, and not only regular delivery, but ability to modify specifications that are on file and to transpose the order in which specifications are to be filled. As a practical matter ability on the part of the mill to render delivery service to the customer depends upon system. The better the system of handling orders the more readily modifications can be made.

By no means, however, does the whole matter rest with the manner in which orders or specifications are handled after they are received. The work starts with the sales department, whose duties formerly were regarded as being confined to selling as much tonnage as possible and at as high prices as possible. Now the duties and responsibilities of the sales department are much broader. It must pick the best customers, those whose orders will prove most profitable, price and actual cost of production being considered. It must endeavor to sell tonnages that will stay sold and to customers whose trade can be counted upon year after year. The sales department and the operating department work more and more closely together.

The railroad furnishing the best passenger service may make the least money. The steel mill furnishing the best service should make the most money, for the rendering of good service is the result of system and efficiency, which are always certain to pay. Opportunity for competition or rivalry being afforded, there is less occasion for price competition, hence market prices have less disposition to fluctuate.

Service means holding customers, hence an intimate relation between producer and consumer is built up and the producer has not the former incentive to encourage buyers to place orders farther and farther ahead. Some of the great buying movements of the past in the steel market were produced by tactics directly calculated to induce buyers to place contracts for another quarter or half year, and then for still another period. The later policy is to sell only a reasonable distance ahead and to take regular customers on for another delivery period when the proper time arrives. Accordingly the sales department is not bent upon selling the mill up for greater and greater distances ahead, but upon making sales commitments with which the subsequent orders or specifications will closely harmonize. The salesman is helping to run the mill efficiently instead of gathering up orders promiscuously and letting the mill take its chances in filling them.

Imagination And Success

COLONEL JOHN J. CARTY of the American Telephone & Telegraph Co. has honorary degrees from universities and decorations from Governments and emperors and kings enough to satisfy almost anyone. Lately, however, he has received two more: the Distinguished Service Medal of the United States, and Commandant of the Legion of Honor of France. His achievements in establishing communications at the battlefront and elsewhere during the war have already been discussed and acknowledged, and the present official recognitions are abundantly warranted.

We recall after the war with Spain a little script that had an enormous circulation, called "A Message to Garcia." It told of a Navy Lieutenant who had a message to deliver, and he delivered it. This called for energy and perseverance and pluck and all the virtues which we may safely include in our advice to young men who are making a good start. CARTY'S task was different; it called for a measure of invention that is beyond most of us, as well as the inspiration of a great force of men and women to pull together, to work and to endure with patience and with all their minds and hearts until the dawn of victory.

Once upon a time when the telephone company was in its beginning he was only one of a number of men working with their wires, until it was observed that he used his head outside of business hours. Then when the problems of the day seemed insoluble it was CARTY who had been thinking over what might happen and who had a solution ready. He had the knack of calling upon his own intellectual reserves and making them work. Others might have done it, perhaps, but he was the one who did, and so they made him chief electrician —because they had to call him something that indicated authority. That was the start, and those marvelous reserves of his have been functioning in applied science unto this day. In telephony his is usually the last word in the art, and he is not an old man yet, by any means. Of course his native gifts were unusual, and but few of us have such endowments of imagination coupled with precise and mathematical thinking.

We refuse to practice hypocrisy, and to tell any boy who works for the telephone company that he may follow in the footsteps of Dr. CARTY. The chances are against it. But while no two of us are alike we have, or the most of us have, the gift of imagination, and in the work to which we refer we find his imagination constantly in function.

In taking a cue from his career if we were to offer advice to young men we should restrict ourselves to those who have the gift of wondering about things. Then we should urge upon them to take this gift along with them into daily life and after a while to see what dreams come true. If it seems straining a point to say that the sound of the harp that once through Tara's halls its soul of music shed may accompany higher mathematics and physics—here's the evidence of it.

Readers' Views and Comments

Contributions by Metallography to L'Art Nouveau

To the Editor of Chemical & Metallurgical Engineering

Sir: Those who saw the Post-Impressionist Exhibition of paintings and sculpture held in New York shortly before the war will recall that one of the most engaging canvases bore the title, "Nude Descending a Staircase," that it might have hung with propriety in any Sunday School library, and that all that was visible to the properly naked human eye was the effigy of many shingles flying through the air. Those who have followed the Cubist and other Post-Impressionistic schools of art will immediately recognize in the accompanying microphotographs taken from a paper by F. G. Smith read before the Institute of Metals Division the remarkable designs which develop in twinned crystal forms of certain non-ferrous metals, more especially in brass and alloys of tin.

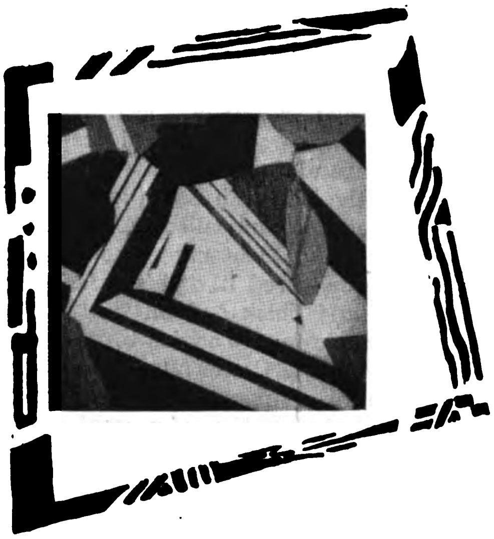


FIG. 1. AJAX DEFYING THE LIGHTNING
Brass (Cu 67, Zn 33) annealed ½ hr. at 650 deg. C. and ½ hr. at 850 deg. C.

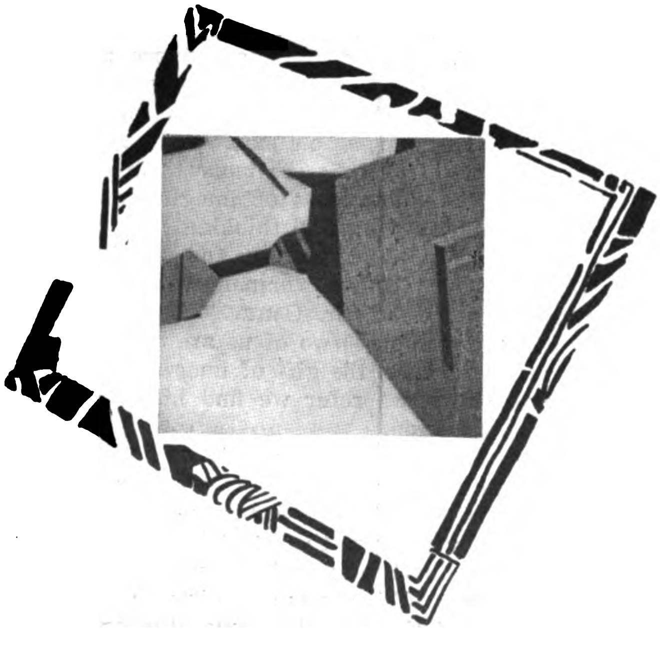


FIG. 2. ALASKAN SNOWS
Brass (Cu 67, Zn 33) annealed ½ hr. at 550 deg. C. and ½ hr. at 850 deg. C.

Fig. 1 indicates, from a Cubist standpoint, a representation of Ajax Defying the Lightning. Ajax will be recognized as standing at the extreme left, in the shadow of a rock in the lower left foreground (which explains his dark color). The lightning is clearly defined in bold zigzag strokes, and the flying timbers at the left indicate a Kansas cyclone. The somewhat exaggerated but subtle note of a blown leaf is rather distinctive of Matisse than of Pares. The real origin of the picture is a field of twinned crystals in brass: (67 per cent Cu, 33 cent Zn) reannealed at 850 deg. C. for ½ hr. after ½ hr. at 650 deg. C.

The same brass reannealed for ½ hr. at 850 deg. C. after ½ hr. at 550 deg. C. reveals a remarkable Cubistic impression of Alaskan Snows. The door of the prospector's cabin is shown on the right, with the surging billows of snow in the foreground on the left. The study is full of pathos, showing the cabin door open to the blast, the frail tenement obviously abandoned, while the observer perceives in the visible distance the rear of the dog-sled as it is drawn away. This indicates that the prospector is out of provisions, and is setting forth in quest of food. The sub-title might well be The Drive of Hunger.

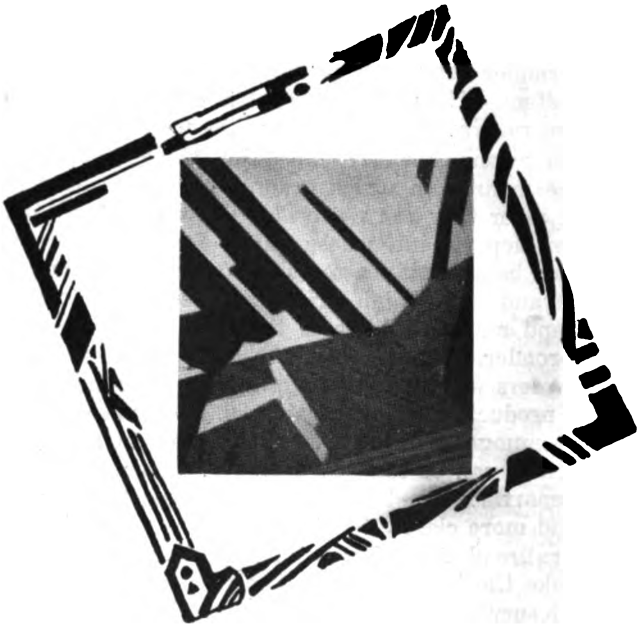


FIG. 3. THE APPROACHING STORM
Same as Fig. 2 after 3000 kg. pressure and reannealing

The structure shown by a field of the same brass that has been under 3000 kg. pressure after reannealing under the same conditions as in the case of that shown in Fig. 2 is entitled, as a picture, The Approaching Storm. One sees the deluge of rain beating against a

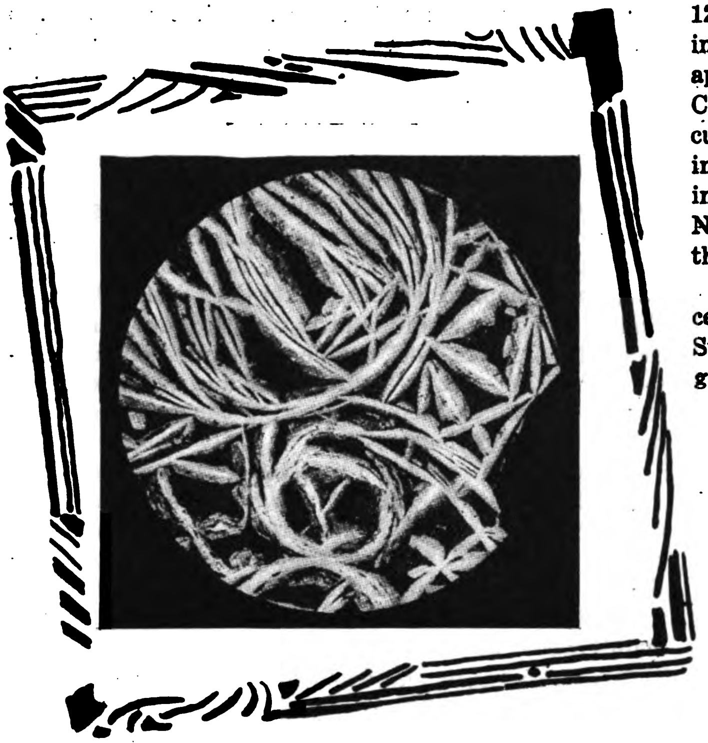


FIG. 4. WOUNDED BIRD IN NEST
Alloy (Sn 70, Sb 20, As 5) etched 12 hr., × 4

wayside signboard on the right, while on the left the lightning flashes through the sky and rends the brown bosom of the earth.

Very different indeed are the results obtained by alloys of tin with arsenic and antimony. The accompanying microphotographs are of crystals found in a ternary system between tin, antimony and arsenic. Fig. 4 shows a Sn 70, Sb 20, and As 5 per cent alloy etched 12 hr., × 4, and reveals the change of cuboidal crystals into curvilinear forms as the arsenic content reaches approximately 5 per cent. The value of these designs in Cubistic art is slight, but if we hark back to the long, curved lines of that phase of draughtsmanship following Aubrey Beardsley and his cult, we find them full of inspiration. We have named Fig. 4 Wounded Bird in Nest. Of course wounded birds do not usually take to their nests, but we claim the privilege of artistic license.

No. 5, which is an alloy of Sn 77, Sb 18, and As 5 per cent, contributed, as in the case of No. 4, by Messrs. Stead and Spencer at a recent meeting of the older organization, the Institute of Metals of Great Britain, is a Japanese scene which might be called Morning-Glories in the Rice-fields After a Storm.

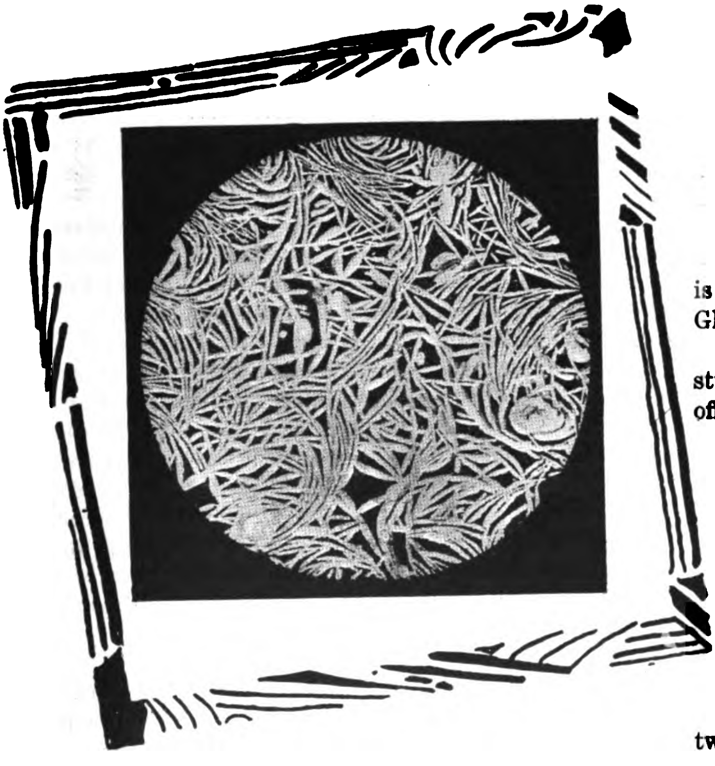


FIG. 5. MORNING GLORIES IN THE RICE-FIELDS AFTER A STORM

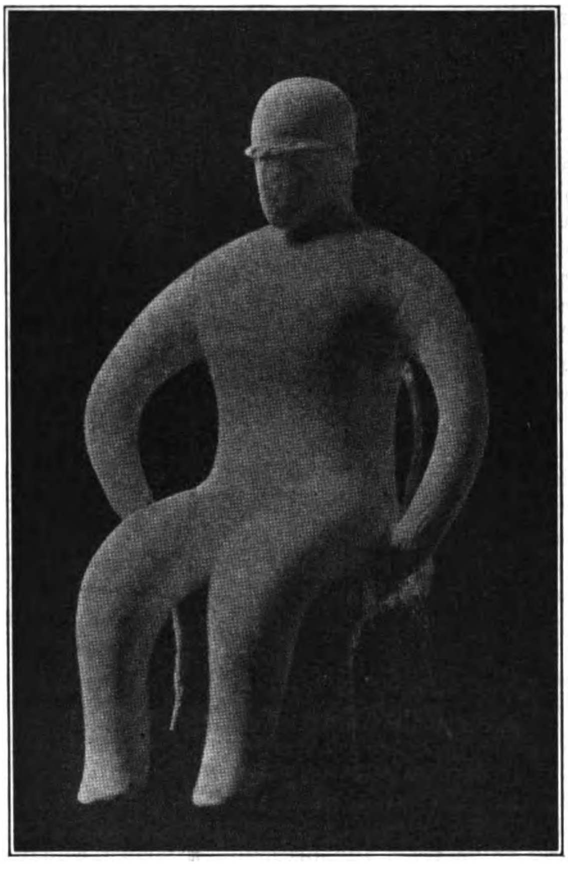


FIG. 6. THE HOST
($CaSO_4 \cdot 2H_2O$)

We have heard so much of the need of Art courses for students engaged in science and engineering that we offer this sketch to demonstrate that our metallographers are making contributions fully as good as, if not better than, the most advanced of the school of Post-Impressionist painters.

To prove our contention we submit along with the microphotograph of the metallographers a bona fide reproduction of a piece of modern sculpture now on exhibition at the famous galleries of Messrs. Knoedler & Co. on Fifth Avenue, New York. It is entitled "The Host," and is by the well-known artist Elie Nadelman. It stands about two feet in height as we recall the original, and the price in plaster is eight hundred dollars.

MARTIN SEYT.

University and College Endowment

To the Editor of Chemical & Metallurgical Engineering

SIR:—In these days when the demands upon our income are more multitudinous and insistent than ever before there is greater need and reason than ever that each new claimant present as clearly and convincingly as possible the facts upon which his claim to support is based, and as the Massachusetts Institute of Technology has found it necessary to appeal to its friends for the great sum of $10,000,000 I shall be grateful if you can allow me the space required to state briefly the case for the Institute and the justifying reasons for this appeal.

The international standing of the Institute as probably the foremost school of technology in the world is generally recognized and further demonstrated by the fact that its student body includes a larger proportion of foreign pupils than any other institution in the country, while the influence of the school upon our own industrial development has been far reaching and profound. This was strikingly brought out at the Congress of Technology held in 1911 in commemoration of the fiftieth anniversary of the signing of the charter of the school. The papers presented by Institute graduates at that time covered the entire field of engineering and science in their applications to industry. The fundamental principles on which the school is founded are the importance of being useful and the way to learn is to do, and these principles have been consistently practiced and developed for more than half a century.

That the community is not unmindful of the value of the Institute training is shown by the recent phenomenal and even embarrassing increase in the number of its students. The magnificent new buildings in which the school is housed were, with what seemed to be ample foresight, designed to accommodate an attendance of 2000, and until this year the student body was well below that figure. This year the number of students has suddenly jumped to more than 3000, thereby straining to the utmost the physical equipment of the school and placing an undue burden upon an already overworked teaching staff.

The devoted and highly trained teachers who constitute the faculty of the Institute have no thought of turning aside from the pressing problems which confront them, but can a self-respecting community continue indefinitely to accept such loyal service without removing the present necessity of sacrifice which it entails? Under normal conditions a member of the teaching staff at the Institute, after an expensive education, is about 30 years of age when he is made assistant professor at a salary of $2000, and about 40 years of age when he becomes a full professor at $3000. The average salary of the full professors is now $3600, and only five out of a staff of nearly 300 receive the maximum salary, which is $5000. Under the present economic conditions it is obviously difficult and may soon become impossible for men of this capacity to resist the constantly increasing pressure from the industries. Dr. Maclaurin, the president of the Institute, states that if this condition continues for five years the results will be most serious and if it continues for ten years the results will be disastrous. It is to remedy this condition and to provide the new facilities required for housing and training the men who are seeking its instruction and upon whom the industrial future of our country must so largely depend that the school calls for these new funds and confidently directs that call to all those who believe in the importance of being useful.

ARTHUR D. LITTLE.

Cambridge, Mass.

M.I.T. Alumni Vocations

In connection with the endowment campaign now going on among the alumni and friends of the Massachusetts Institute of Technology, approximate figures have been compiled which indicate the relative distribution of the graduates in industry. It appears that about one-half practice the engineering professions, one-quarter go into manufacturing and the remainder follow lines in which their engineering education can have beneficial application.

There have been 14,000 registered students at Tech. and 7015 graduates, 6000 of whom are included in the following classifications. The groups are somewhat arbitrary and might be re-arranged. However, the subclasses are not definite enough to permit any very detailed deductions. The professional engineers' class is mainly made up as follows:

ENGINEERING PROFESSIONS CLASSIFICATION

Electrical engineers	560
Teachers of engineering	503
Mechanical engineers	446
Railroad engineers	322
Architects	301
Civil engineers	262
Draftsmen	64
Naval architects	40
Marine engineers	44

The chemical, metallurgical and mining engineers will be included in the manufacturing class because it is assumed that the majority are so engaged. The mechanical engineers are also extensively occupied in manufacturing, and the number so engaged approximately offsets the engineers erroneously included in the following manufacturing classification:

MANUFACTURING CLASSIFICATION

Mining and metallurgical engineers	351
Miscellaneous manufacturing	350
Manufacturing chemists	252
Steel and iron companies	161
Textile companies	105
Chemists	90
Rubber companies	59
Soap and glue companies	44
Paper companies	40
Gas companies	36
Sugar and starch companies	28
Powder and explosives companies	26
Electrochemical engineers	28

The small number of men reporting themselves as chemists is quite illuminating, when it is considered that several times this number have graduated as chemists. However, this is no reflection on the chemical course given, for it may rightly be assumed that the training of these missing chemists has been such that they could apply themselves more profitably out of the laboratory. The course a man takes does not necessarily have everything to do with his final vocation. David Wesson graduated as a metallurgical engineer, and no doubt he was an able one. However, better opportunities opened up in the edible-oil industry and he applied his thorough Tech. Met. training to this field, with the well known result that the name Wesson has largely supplanted that of olive in the edible-oil industry.

The benefit of our technical institutions to the community is much broader than can ever be appreciated, and it is hoped that the community will generously square up a few of the silent but evident bills receivable now held against it.

National Conference of Business Paper Editors

Responding to the call issued by Samuel O. Dunn, president of The Associated Business Papers, Inc., in pursuance of the resolution adopted by the executive committee of The Associated Business Papers, Inc., at New York, Oct. 6, 1919, 67 editors and editorial representatives assembled at the Hotel Astor, New York City, Nov. 13, to consider the formation of an editorial conference of The Associated Business Papers, Inc. It was decided to form a National Conference of Business Paper Editors, the purpose of which is:

To provide an organization for the discussion and formulation of constructive editorial policies, held in common by the business press; to furnish the medium for disseminating the results of these discussions through co-operation; to provide by close contact of the editors, inspiration for editorial achievement and the fuller realization of the existing individual and collective responsibility as leaders of thought in the industries they serve; and to perform such other functions as may further the aims of this Conference.

The officers elected are: President, A. I. Findley, *Iron Age*, New York; vice president, Clay Cooper, *Mill Supplies*, Chicago; secretary-treasurer, R. Dawson Hall, *Coal Age*, New York; executive committee, J. C. Chase, Class Journal Co., New York; B. O. Hough, *American Exporter*, New York; W. R. McQuilkin, *National Builder*, Chicago; E. T. Hawson, *Railway Maintenance Engineer*, Chicago; C. J. Stark, *Iron Trade Review*, Cleveland; Harvey Whipple, *Concrete*, Detroit.

There will be three meetings each year, one in midwinter, one in the spring and the third in conjunction with the annual meeting of The Associated Business Papers, Inc. One of the two editorial meetings will be held in the East and the other in the West. Special meetings may be called at the discretion of the executive committee.

The time and place for the midwinter meeting was left to the discretion of the executive committee.

Extension of Trading-With-the-Enemy Act

Continuation of the trading-with-the-enemy act until Jan. 15 has been provided by a joint resolution passed by the Senate and the House of Representatives. The resolution was made necessary because of the possibility of ratification of the Peace Treaty by the Senate. Ratification of the Treaty would terminate the trading-with-the-enemy act and would permit the dumping of German dyes, as no law has been enacted to protect the domestic dye industry. While the House has enacted such legislation, the Senate, due to the consideration of the Peace Treaty, was unable to take up the consideration of the dyestuffs bill. The resolution which has been adopted by the two houses provides "That notwithstanding the prior termination of the present war, the provisions of the trading-with-the-enemy act, approved Oct. 6, 1917, and of any proclamation of the President issued in pursuance thereof, which prohibit or control the importation into the United States of dyes or other products derived directly or indirectly from coal tar, are continued until Jan. 15, 1920." The only objection which was offered, and that later was withdrawn, was caused by a telegram from a textile manufacturer which read as follows: "Very important for cotton mill industry that foreign fast color dyes are admitted without further delay or hindrance. One cotton manufacturer has a million and a half dollars worth of shirting cloth requiring these dyes. He is unable to deliver it without the dye. Meanwhile many million dollars worth of these shirtings with fast dyes recently have been bought in England for importation to this country. Our print works has many thousand pieces held up for lack of fast colors. We certainly will lose our export trade in shirting unless permitted to secure dyes available to foreign competitors."

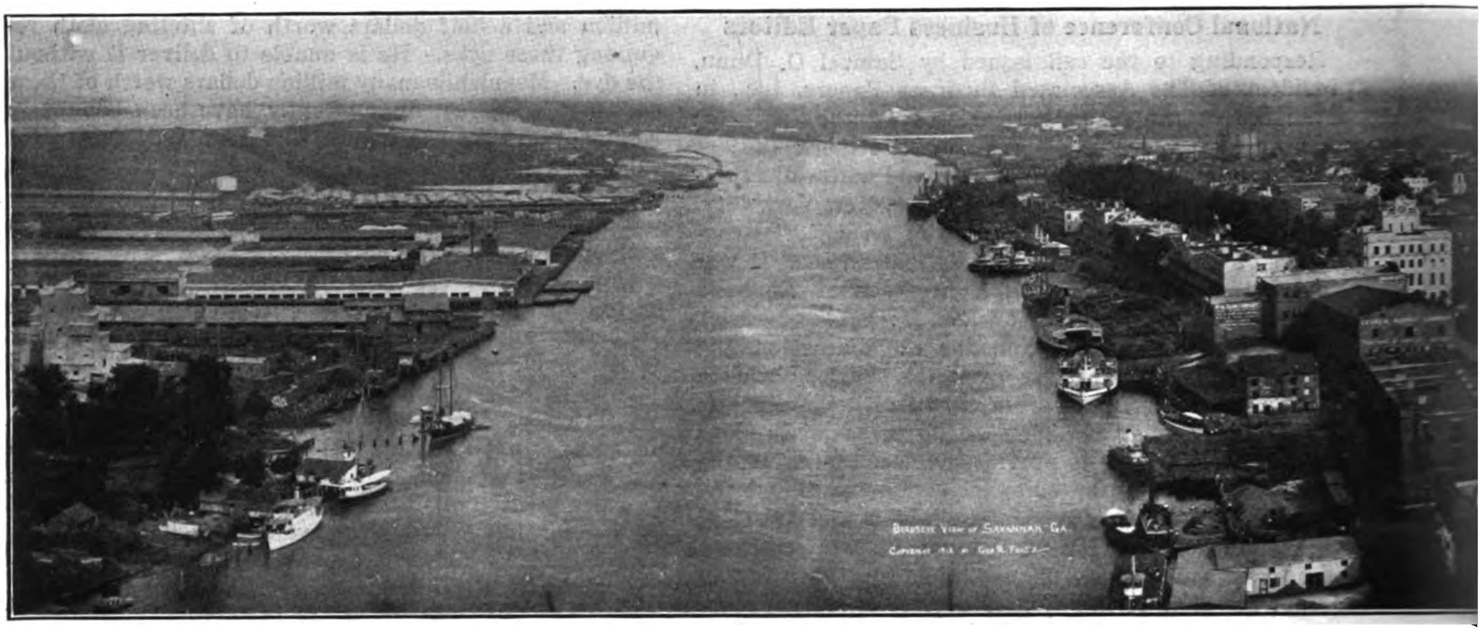
During the discussion of the resolution, it was stated on the floor of the Senate that the War Trade section of the State Department is not functioning as efficiently as it should. It is anticipated that the resolution will have to be extended, as it is not probable that the consideration of the dyestuffs bill will have been completed by Jan. 15. The Senate is unalterably opposed to the licensing system, and Senator Smoot of Utah, as strong a protectionist as he is, declared in the course of the debate that he would not vote for a license system even though he knows it to be necessary to the protection of the dyestuffs industry.

Anti-Tuberculosis Campaign

While science is making rapid strides in chemistry, adding each year to the productivity and comfort of the civilized world, the physical vigor of that world is threatened by an insidious disease. The centuries-old plague—tuberculosis—is now killing hundreds of thousands of persons and incapacitating millions every year in three big nations for which reliable figures are available. In each of these nations, Great Britain, France and the United States, a determined effort is being made to check the ravages of the disease, which, experts agree, is not hereditary and is both preventable and curable.

The death toll in the United States is 150,000 a year, the active cases number more than 1,000,000 and the unsuspected cases greatly exceed the known. To combat this menace the National Tuberculosis Association has undertaken an intensive campaign on such a scale as to warrant expectations of saving tens of thousands of lives and averting the physical breakdown of many thousands of workers as the result of a year's work. The amount required for a nation-wide drive against the "White Plague" will be approximately $6,500,000, which fund will be raised during December by the sale of Red Cross Christmas seals at a penny each.

Working in co-operation with its 1000 affiliated State and local organizations, the National Tuberculosis Association plans to carry to the great masses of the people the simple truths regarding the disease—that it is most effectively fought by fresh air, scrupulous cleanliness and good food, which build up the bodily resistance against disease germs. Employers are to be impressed with the necessity of keeping up to the minute in providing protective devices against dust and dyes and impure air, which weaken the lungs and thereby increase the danger of tuberculosis. Physicians everywhere will be asked to redouble their efforts to search out unsuspected cases, and communities will be urged to provide clinics, dispensaries, hospitals and sanatoria in sufficient numbers to assure proper treatment for all afflicted persons. By such means it is believed that a long step will be taken to the great goal, which is the bringing of the disease under complete control.


Birdseye View of Savannah Ga.
Copyright [illegible] by Geo R. Foltz

Savannah Meeting of the American Institute of Chemical Engineers

Report of the Annual Meeting Held at Savannah, Georgia—Election of Officers—Address of President-Elect David Wesson on the History and Development of the Cottonseed Oil Industry—Excursions

FOR several reasons the selection of Savannah is preference to one of the usual convention centers for the twelfth annual meeting of the American Institute of Chemical Engineers proved to be a very happy one. The four days, Dec. 3–6, were ideal, thus adding to the pleasure of those in attendance while getting better acquainted with one another as well as with the hospitality of Georgia. It was peculiarly fitting that recognition should be made on the twentieth anniversary of the process of refining cottonseed oil as devised and first operated in Savannah by the Institute's president-elect, Dr. David Wesson.

The commodious tourist hotel DeSoto was opened in advance of the usual winter season schedule especially, that its homelike attractions might give the meeting seclusion and an atmosphere of a great family gathering. The Hon. Murray M. Stewart, mayor of the city, gave the address of welcome, to which President Arthur D. Little responded. The reports of committees were received. That on the canvass of ballots reported the following officers elected:

President, David Wesson; first vice-president, Henry Howard; second vice-president, Albert W. Smith; third vice-president, Hugh K. Moore; secretary, John C. Olsen; treasurer, F. W. Frerichs; auditor, C. F. McKenna.

In the annual report of Secretary Olsen, it was stated that the total membership of the Institute had reached 344. This led to considerable discussion. Dr. Little stated that there were at least 2000 chemical engineers in this country and with such a restricted membership the society could not be considered as unqualifiedly representing the profession. It was finally decided that the council, when it seemed desirable, could waive any or all the qualifications required by the constitution for an applicant to have his name placed on the ballot. This was especially designed to bring into the society certain men of undoubted professional qualifications and attainments now disqualified.

Resolutions were passed indorsing the Longworth bill providing for the licensing system on dye importations, and immediately forwarded to the Senate. Longer and more thorough courses in chemistry and engineering were recommended for technical students.

Because of the attractions provided by the entertainment committee headed by Mr. Frank N. Smalley, the sessions allotted for the reading of papers were not allowed to take their usual dominant position. The available time was used in reading selections which were then discussed. Space will not now be devoted to the details of this part of the program, as nearly all the manuscripts will be published in full at an early date, collectively in the semi-annual *Transactions* of the Institute and separately in subsequent issues of this and other journals. The addresses of the retiring and incoming presidents, Doctors Arthur D. Little and David Wesson, dealt especially with the South. The former will be published in full in a later issue, while the latter is given herewith, in part.

NOTES ON EXCURSIONS

The weather was favorable for the excursions, which were both pleasant and instructive. A motor trip to Bethesda (Wednesday), a steamer trip on the Savannah River with stopover at Port Wentworth's lumber mill, sulphate pine pulp mill and shipyard and at various warehouses along the route (Thursday), visits to the plants of the Southern Cotton Oil Co. and the American Agricultural Chemical Co. (Friday), all contributed to make these side lines of the annual meeting long to be remembered.

History and Development of the Cottonseed Oil Industry

By David Wesson

It seems particularly appropriate at this first meeting of the Institute of Chemical Engineers in a Southern city that an effort should be made to tell the story of how a great industry has been founded and built up on what was once a by-product and a nuisance.

The early records do not tell us much. We find in the statistics of South Carolina published in 1826 that Dr. Benjamin Waring established a mill at Columbia, S. C., and expressed from cottonseed a very good oil. Georgia had an oil mill in 1832, but little is known about it. C. D. Arfwedson, an English traveler, in his book entitled "The United States and Canada, 1832, 1833 and 1834," states, "In many places it is usual to manure the fields with the seed not used for planting, but of late years experience has taught the planters to set a higher price on it, as it contains a considerable quantity of oil which is extracted by pressure and is suitable both for burning and painting. The oil may in the course of years become an additional source of wealth to the planters."

Up to the time of the Civil War and in fact for some time after, the disposal of the seed was always more or less of a problem. Much of it was used for fertilizer, and a great deal of it was thrown into the water courses. In 1857 the State of Mississippi passed laws fining gin owners who allowed seed to accumulate at gins located near towns and villages, where it was apt to become a nuisance. The fine was $20 per day after the fifth day. Another law imposed a fine of $200 for throwing the seed into water courses the waters of which were used for drinking and fishing.

The industry began to assume some importance just prior to the Civil War, after which it commenced to grow. In 1860 there were seven factories employing 183 workers. In 1870 26 factories employed 644 workers, while today about 900 factories give employment to about 20,000 workers and 5000 officers and other salaried men.

The causes for the rapid growth of the industry are various.

First, the rapid increase of population all over the civilized world made increased demands for food. The doing away with the large cattle ranches of the West reduced the meat supply so that the hogs which formerly furnished an adequate supply of lard were more and more eaten as pork and a demand was made for an edible fat to replace the lard. This demand is largely met at this time by cottonseed oil and the growth of the cottonseed oil industry is largely coincident with the decrease per capita of the hog lard supply.

Second, the cottonseed oil produced in the early days of the industry was very irregular in quality. In 1879 it was used in small quantities to adulterate lard, but the quality was such that it did not improve the mixture. The application of chemistry to the industry at this time started it upon a rational basis and gave such a stimulus that it has grown by leaps and bounds ever since. The advent of the chemist started improvements in the quality of the oil and at the same time pointed the way to economies in production.

The most important work of the chemist has been in refining the oil and improving the products made therefrom. To do this principles had to be established in the laboratory and applied in the factory.

EARLY REFINERIES

The first crude oil was used for paint and burning in lamps. The early refineries kept their methods so secret that it has been difficult to discover when oil was first refined in this country. The writer remembers being told in 1870 that peanuts were pressed to obtain oil which was mixed with that of the cottonseed and sold for olive oil.

The early refineries were connected with the oil mills, but there soon arose people who recognized that refining the crude oil as furnished by the mills was an industry by itself and refineries started in several places.

The crude oil in the early '80s was sold on color and flavor and in case of disputes referred to committees. About this time the chemists discovered that free fatty acid in the crude oil was an index of quality and refining loss and applied the test in judging value of samples. A small-laboratory refining test was made to see if the samples of crude would refine to a good color. The writer used this method in Chicago in 1887 and when in 1890 he commenced to reject oil in New York on account of high acidity he encountered much opposition, some mill owners protesting that they had never had any fatty acids on their premises.

Shortly after 1880 cottonseed oil began coming to Chicago in considerable quantities. Here it was refined with caustic soda, bleached with fuller's earth, mixed with prime steam lard and oleo stearine and went into commerce as refined lard. In 1887 it was discovered that more lard was shipped from Chicago than came there either on the hogs killed there or as lard itself. Congress started an investigation and discovered that cottonseed oil was the cause of this great increase. They also discovered that the 30 to 40 per cent of oil in the compounds did not injure them from a health standpoint, though the oil used at that time did not improve the flavor.

About 1892 or 1893 the practice of deodorizing was started in Chicago. This consisted in heating the oil in a tank provided with a large steam coil and then blowing live steam through the oil to remove flavor and odor. The oil was afterward cooled to normal temperature. This process, while producing a greatly improved oil, did not turn out a perfect one by any means. It allowed the lard substitute maker, however, to use a mixture of about 82 per cent oil and 18 per cent oleo stearine, which proved quite satisfactory to the trade.

THE WESSON PROCESS

In 1899 the "Wesson process," so called, was discovered and the first plant was put in operation in Savannah the following year. The product of this plant set a new standard for cottonseed oil, which has now become the chief source of edible fat next to butter in this country. From the discovery of the Wesson process to about 1910, lard substitutes were made almost entirely of mixtures of oleo stearine and deodorized cottonseed oil. The packer controlling the former put its price very high and the demand for a cheaper material was supplied by the discovery of the hydrogenation process which fulfilled the dream of the fats chemist by furnishing a ready means of saturating the double bonds of the fluid oils with hydrogen and converting olein and linolein to stearine. By passing hydrogen gas through oil at a temperature of 180 to 200 deg. C. in the presence of finely divided nickel, cottonseed oil can be hardened to any extent up to a melting point of about 60 deg. C.

The lard substitutes of the present day are almost entirely produced either by partly hardening the whole oil or by adding sufficient completely hardened oil to that which has not been so treated. Besides the use of the oil in lard substitutes, which utilizes at present about 75 per cent of the total production, large quantities are used for table oils, oleomargarine, or margarine, as it is called in Europe. Considerable oil is also used in medicine.

In refining the oil an average of 9 per cent is taken out by the alkali in the form of soap stock. In the early days this was made into cheap laundry and mill soaps. Later it was made into washing powder by first saponifying and washing, then mixing with soda ash or salsoda. At best the soaps made directly from the soap stock were poor in color and possessed an unpleasant odor. It is the practice in several large plants to decompose the soap stock with acid, then saponify by the Twitchell process or otherwise and distill the fatty acids from the black elastic pitch which remains. This pitch is used in making paints used for roofing. During the war considerable quantities of glycerine were recovered from the soap stock, but on account of changed conditions it has been found better to treat the soap stock with centrifugal machines of the cream separator type and recover a considerable quantity of the entrained neutral oil.

EARLY CRUDE OIL MILL PRACTICE

The first crude oil mills were somewhat primitive compared with those of the present day. No attempt was made to separate the lint from the seed before passing through the hullers. In those days the seed carried so much lint it was customary to figure meats and hulls as equal in quantity. The early mills burned the hulls under the boilers together with the trash in the seed. The separation was very poor and the hulls frequently carried large quantities of uncut seed and meats which helped account for the high hull percentage.

The separated meats were crushed between rolls, cooked in jacketed heaters and pressed in box presses provided with thick camelshair mats between which the bags holding the meats were placed. The yield of oil was small, a large amount being left in the cake and lost with the meats which went into the hulls.

An important by-product of the old-time mills was hull ashes, which amounted to about 20 lb. per ton of hulls and were rich in potash and phosphoric acid. Actually the ash present was several times that recovered. On account of the character of the hulls much of the ash was carried up chimney. About 1887 it was found that the hulls could be used for fodder and cows have been eating them at increasing prices ever since. At the same time plat presses superseded the old boxes and better work was done in the press rooms. Linter or linter gins were also installed and the short fibers or lint was partly removed from the seed before hulling.

In 1887 the writer started a small laboratory in Chicago for analyzing mill products for the American Cotton Oil Co., which had just come into existence. The results on 244 samples of cake showed an average of 13.55 per cent oil, while 226 samples of meal averaged 12.18 per cent. Hulls were not analyzed, but inspected for meats and uncut seed. This was the beginning of mill control work in the industry. It has caused great economies and pointed the way to the use of better machinery. At the present time the meal runs from 6 to 7 per cent oil.

The cottonseed cake has always been either exported as such or ground into meal and used as a cattle food or fertilizer. One of the latest developments is the extraction of the oil from the cake and meal by solvents. At present prices this is a profitable industry. There is no good reason why solvent extraction should not be applied to the entire meats, cutting out the press-room expense and recovering 50 to 60 lb. of oil per ton of seed. If this were done it would have saved last year nearly 500,000 bbl. of oil, worth about $34,000,000. There is nothing to prevent this development except fear of fire risk and investment of capital. It is a comparatively simple engineering problem which many of us will doubtless live to see accomplished.

Owing to war conditions many oil-bearing materials and oils have been brought to this country and handled in the cotton oil mills and refineries. So great has been the variety and quantity of these different oils that it would seem more proper at the present time and in the future to talk of the vegetable industry.

Commercial Possibilities in the Electrochemical Production of Organic Compounds*

Description of Prospective Industrial Applications of Organic Electrochemistry — Advantages and Disadvantages Inherent in Electrochemical Methods — Conditions Favoring Economy in Operation, Catalytic Effect, Diaphragms—Some Suggested Organic Electrosyntheses—Status of the Industry

BY C. J. THATCHER, PH.D.

WE ALL know that, in industrial applications at least, the electrochemistry of the organic compounds has not kept pace with the progress in other lines of electrochemical activity. Probably most of us would have difficulty in naming more than a few organic compounds which have been successfully manufactured by electrochemical methods, at least in this country. Indeed, progress in this direction has been so restricted that there has been, or seems to be, hardly any interest in this branch of the electrochemical industry.

It is true that in February, 1915, this Society held a symposium consisting of three papers on the subject of organic electrochemical manufacturing, followed by a discussion in which a number of members took part. Both optimistic and pessimistic opinions regarding the future were expressed in the papers and discussions. Whatever may have been the general consensus of opinion, it is certain that the symposium did not cause any noticeable activity in the electrochemical production of the carbon compounds despite the apparently favorable opportunity presented by the war. At that time I myself was preparing to manufacture and have since manufactured, electrochemically, several tons of paramidophenol sulphate—an intermediate and a photographic developer—and have also since then made anthraquinone and hydroquinone on a small-factory scale; but no other serious attempts to establish organic electrochemical operations during the war now ended have come to my attention.

Perhaps the period intervening since that symposium has not been the most propitious; for old and established processes were almost certain to bring needed and highly profitable results, and there was little or no time for laboratory or plant experimentation. However, that period is now passed, and enterprising American manufacturers are again confronted with the necessity for improvement and economy in production, in order that they may keep ahead of domestic and foreign competition.

PROSPECTIVE INDUSTRIAL APPLICATIONS OF ORGANIC ELECTROCHEMISTRY

Since it is in the new and comparatively favored field of dyestuff and other organic products that industrial preparedness against foreign competition will be most necessary, it would seem that we electrochemists should now seriously consider, with an open mind, whether we cannot blaze a path in this as we have in other directions. We do not need to be reminded that Yankee optimism, courage and ingenuity have, when once aroused, turned failures into successes, and confounded the wise in other countries. Our friends the enemy—in war as in chemistry—have had recent surprises along that line in the Argonne and elsewhere.

Now we have not really tried to manufacture organic derivatives here electrochemically. There is much that we do not know about what has been done or tried in other countries, particularly in Germany. But the mere fact—if it be a fact—that others have tried or failed does not conclusively prove anything as to what the American electrochemist can do.

The real question, which we ought to consider in all seriousness, is whether now and in this country are not the time and place to begin more or less extensive industrial applications of organic electrochemistry. To awaken some sustained interest, consideration and discussion of this question in this or other meetings is the object of my paper, and for this purpose I would ask you to consider, first, the basic principles which may indicate the kind of electrochemical operation which could be expected to be successful commercially; and thereafter to briefly consider specific electrochemical processes.

ECONOMIC BASIS OF ORGANIC ELECTROCHEMISTRY

To this end we may inquire first as to how economic values are created by industrial electrochemistry. That is a question which Dr. Roeber considered in his presidential address before this Society in April, 1914, and it seems well to apply some of Dr. Roeber's considerations to the subject of this paper.

Economic values are created by industrial electrochemistry—as in other similar lines of activity—either as time value, place value, or form value. Time or place value of organic electrochemical products is mainly due to their high energy content, which can be imparted to them more economically by the electric current. Such products are valuable mainly because they enable us to transmit their stored energy to another time or place. Calcium carbide and aluminum when used in aluminothermic reactions are examples of electrochemical products having a high time and place value. Their potential energy becomes kinetic whenever or wherever desired. These and other products of electrochemical industries acquire their economic value by serving as a medium for electrochemical power transmission. Many or most of this class of products are made by electrothermic methods.

But another and important class of electrochemical products has nothing to do with chemical power transmission. These are products which have a high form value, i. e., those which derive their intrinsic value from the mechanical and chemical work expended and dissipated in transforming the raw materials into the desired finished product. Qualities other than a high specific content of energy impart the economic value to this class of compounds. Caustic soda, bleaching powder and electrolytically refined copper are examples. Such products are made by electrolysis, for the most part; they have a high form value due to the work expended during electrolysis upon comparatively cheap raw material. In the production of nitric acid or nitrates by atmospheric fixation, the raw material, air, is more than cheap, it has no economic value, we may say. Therefore the form value of nitric acid and nitrates so produced is unusually high.

---

*Read at the Chicago meeting of the American Electrochemical Society, Sept. 26, 1919.

On the basis of past experience, and reasoning by analogy, we may conclude, therefore, that products which have a high form value are such as stand the best chance of being economically produced by electrolytic methods. The comparatively wide margin between the value of the raw material and the finished product permits a considerable saving whenever electrolytic methods reduce the cost of the mechanical and chemical work put into the operation. This comparatively large saving often more than offsets the interest and other charges due to the design and construction of electrochemical equipment.

This somewhat abstruse consideration has a very practical bearing upon the subject of this paper, for it will help to decide whether electrochemical methods of production may be expected to be economical in the manufacture of organic compounds, and it should enable us to tackle the problem along the lines of least resistance. Electrothermic methods are almost but not quite excluded in the manufacture of the carbon compounds. It is in the technical applications of electrolysis that electrochemical operations should succeed if at all. And our prior consideration teaches that a very large number of organic compounds should be capable of being produced electrochemically, because of the vast number of organic compounds which have a high form value. The carbon compounds (particularly the aromatic compounds, such as dyestuffs) have a high form value, more so than inorganic compounds as a class. The average high value of such compounds is not due to a high energy content, nor to the value of the organic raw material, which is often comparatively low. Their value is due, rather, to the amount of manual, mechanical and chemical energy expended and dissipated in transforming the relatively cheap raw materials or intermediate into pure, finished product. And we have seen that just such transformations are a most promising field for industrial electrolytic operations.

We are forced to conclude, therefore, that the basic economic principles are favorable for the profitable production, by electrochemical methods, of a very large number of organic chemicals—all such as have a high form value.

ADVANTAGES WHICH MAY INHERE IN ELECTROCHEMICAL METHODS

Obviously, in the final analysis, electrochemical methods are advantageous only when they are more economical. But economy may be due to several causes. We will consider only the production of known products already in demand, and now produced by chemical methods, and not new compounds which the characteristics of the electrode processes might enable us to produce.

Electrochemical methods may supplant chemical methods;

First: When the same organic raw material is used.

(*a*) By increasing the yield through control of conditions to be later considered.

(*b*) By eliminating inorganic raw materials such as oxidizing or reducing agents, as by substituting electrolytically generated oxygen and hydrogen.

(*c*) By electrolytic regeneration of inorganic raw materials, as for example spent chromic acid liquors.

Calculation will show that with but few exceptions, it is cheaper to oxidize, reduce or substitute by electrolytic than by chemical means, a fact which was brought out by Mr. Lidbury in the symposium previously referred to[1].

This is particularly true when, as is sometimes possible, both the anode and cathode reactions may be made to perform useful work, either in the preparation of the same or different organic products.

But even without such possible economy, electrochemical transformations, figured on an equivalent basis, are usually surprisingly cheaper. For example, with power at metropolitan rates, it costs about ten times as much to oxidize with bichromate as at the anode of a well designed cell. And if an electrolytic oxidation saves 35c. per lb. buying power at metropolitan rates, it is not necessary and may not pay to locate the plant in an inaccessible locality in order to use hydro-electric power at an additional saving of only a few cents per pound.

Whenever, therefore, electrolytic oxygen, hydrogen, chlorine, etc., give as good a yield per unit of organic raw material, we have every reason to expect economy. For any increased charges, inherent in the use of electrolytic equipment, such as interest and depreciation, need not, if the cell is properly designed, be enough nearly to eliminate the economy in favor of the electrolytic method.

There are numerous organic compounds now prepared chemically by oxidation, reduction or substitution, which, by skillful control of conditions in a properly designed cell, can be more economically made electrochemically from the same raw materials as those now used, for one or more of the reasons specified above. Only poor yields, excessive depreciation, etc., can prevent success, and it will be shown that improvement in these particulars can be effected.

Secondly: When a cheaper organic raw material may be used.

It would carry us beyond the scope of this paper to consider the various instances in which such a substitution may be made. Briefly stated, the conditions obtaining at the surface of an electrode are much more variable and controllable than in purely chemical transformations, so that new reactions can be used technically, or a number of intermediate steps may be combined into one operation.

One of the features of electrode processes which accounts for the economy thereby effected is the wide range of gas pressure obtainable at the surface of an electrode by suitable variation of the electrode potential. Referring to this point, Prof. Nernst stated[2] that it was possible to liberate a gas, such as chlorine, at the anode either in greater than homeopathic dilution or at pressures which amount to millions of atmospheres, and that this vast range of pressure made it possible to readily chlorinate organic compounds to every conceivable degree. The importance of the regulation of gas pressure in organic synthesis has been shown in many hundreds of instances. Thus, in organic substitution processes, the number of substituted atoms is often dependent upon the pressure at which the reaction occurs. Since any desired pressure can be so conveniently created, and maintained at an electrode, solely by variation in electrode potential, it is obvious that electrochemical methods should frequently be more direct and economical. As Prof. Haber once stated:

---

[1] MET. & CHEM. ENG., vol. 13, No. 4, p. 211; April, 1915.
[2] Berichte, 1897, p. 1562.

"Whereas the nucleus of the aromatic compound is not attacked by most chemical oxidizing materials, or is completely destroyed, accompanied by the disruption of the ring, electrolysis under favorable conditions permits a smooth oxidation, with the result that the hydroxyl group is introduced into the benzol nucleus. Benzol is thus oxidized in sulphuric acid solution at the anode to hydroquinone, aniline to paramidophenol, azobenzol to tetraoxybenzol, anthracene to alizarine."

No explanation of the economy resulting from such direct syntheses of coal-tar crudes is needed.

Thirdly: When a high degree of purity is desirable. We can oxidize or reduce by electrical energy without contaminating the finished product by foreign materials the complete removal of which is generally troublesome and expensive.

The three general considerations above outlined should be sufficient to show why it will be advantageous and economical to use electrochemical methods in manufacturing organic compounds. And we have also seen that the use of such methods may be expected to be successful in the manufacture of products having a high form value. Let us consider the other side briefly.

DISADVANTAGES WHICH MAY INHERE IN ELECTROCHEMICAL METHODS

The objections to the commercial use of electrochemical methods in preparing organic compounds were very concisely stated at the symposium in 1915, by Mr. Lidbury, in the following words:

"In the first place, to do a unit of chemical work in a unit of time, the electrolytic plant would be usually very much larger than a chemical plant; require very much more room; be usually very much more expensive; require more expert attention, and on account of the extreme severity of the demands of electrolytic methods on materials employed for plant, etc., the upkeep would usually be higher.

"In the second place, the working out of an electrolytic method requires a very much greater amount of time, thought, intelligence and expenditure than the working out of a chemical method. Though this might not amount to much as regards laboratory investigation, anyone acquainted with the electrochemical industry would be aware of the greater difficulties which invariably have to be overcome in preparing such a process for large-scale operation, and in that important phase known as 'establishing practice.'"

I am not sure that we can all agree as to the validity of the first of these objections. However, is it not a fact that such objections could be raised against the adoption of any electrolytic process, inorganic as well as organic? It would seem that almost any electrochemical plant is necessarily larger and is more expensive to design, construct, establish, practice and maintain. We cannot deny the commercial practicability of organic electrolytic plants upon grounds which would deny the practicability of existing successful electrolytic plants. Wherever, for reasons already given, there is any considerable economy of operation in electrolytic methods, higher interest charges due to greater expense in the design, equipment and maintenance of an electrolytic plant are more than offset, at least in any plant producing annually 100,000 lb. or more of an organic product.

CONDITIONS FAVORING ECONOMY IN OPERATION

Electrochemical methods of production are, of course, only economical when operated under skillfully selected and controlled conditions. It is not my purpose to consider such conditions at any great length in this paper. They include electrode material, chemical and electrical conditions, catalytic effects and diaphragm material. Excepting the latter two the complexity and range of variation are too great to be considered advantageously in any general manner. But it will be worth while to consider briefly factors capable of a more general consideration, such as catalytic effects and the use and nature of diaphragms.

CATALYTIC EFFECTS

The nature and importance of catalytic action upon electrode processes were set forth by Prof. Ostwald with customary insight in his paper presented at the International Electrical Congress at St. Louis in 1904[4]. A few quotations from this paper will be most instructive. Prof. Ostwald stated:

"If there are several possibilities for the reaction at one electrode, the readily occurring chemical reaction depends not only on the nature of the possible chemical reactions, but upon the concentration of the substances which are present, and by suitably varying the latter we can bring any reaction to any point in the voltage series."

"In connection with this it should be emphasized that what is called briefly '*the electrode process*' is in reality a rather complex phenomenon."

"It will thus be seen that even the simplest electrode reactions are made up of a plurality of reactions following each other step by step. Since each of the same can be influenced catalytically, it is already evident that a very great variety of results is possible."

"Such means of changing the speed of a given reaction within very wide limits exists really in chemistry in what is called *catalyzers*. Herefrom it is at once evident which very important and essential part the catalyzers are able to play in electrolytic action. By retarding one of the possible reactions by means of a negative or retarding catalyzer, we are able to *exclude* its influence from the electrolytic process. By accelerating by means of a catalyzer a reaction which is of itself slow, we can *include* it into the electrolytic process. In other words, we are no longer compelled to let the current act in the way stated by the above simple law, but in principle we are now able, *by applying suitable catalyzers, to prescribe to the current that reaction which we want to take place*, and it does not matter at which point in the voltage series this reaction is situated. This fundamental idea may be applied in two directions. First, in synthetic work; if we suppress by negative catalyzers those reactions which would take place before the desired one, we can bring the desired reaction to the front, or if the reactions which take place before the desired one take place with a low speed, we can accelerate the speed of the desired reaction by means of a positive catalyzer and can thus produce the same effect. The second application is *for analyzing the reactions which really take place at the electrodes.*"

---

[4] *Electrochemical Industry* (Now MET. & CHEM. ENG.), vol. 2, No. 10, p. 393; October, 1904.

The improvements which may be effected in industrial organic syntheses by suitable control of catalytic action is sufficiently outlined for present purposes in the foregoing. A more detailed consideration of the subject will be found in Prof. Ostwald's paper, in President Bancroft's recent address on "Poisoning of Catalytic Agents"[4], and in papers[5] describing my investigations in Prof. Ostwald's laboratories which called his attention to the subject.

USE AND NATURE OF DIAPHRAGMS

It is probable that the need of suitable diaphragms for an electrolytic cell for the manufacture of organic compounds has hindered the development of the industry as much as or more than any other factor. On account of the nature of organic compounds, many of which are either insoluble or non-electrolytes, it is usually necessary to employ a solvent electrolyte, which tends to disintegrate diaphragms so rapidly as to prohibit commercial operations. Few materials suitable for diaphragms will withstand the corrosive effect of strong acids, alkalis or oxidizing liquids for any length of time. Other materials which might be more resistant become clogged during use, accompanied by a prohibitive increase in resistance.

I encountered such difficulties at the outset of my own organic electrochemical manufacturing, and was obliged to devise a diaphragm suitable for the purpose. This diaphragm, known as Electro-Filtros, has been in commercial use in organic electrochemical operations since 1915; and experience has shown that it is absolutely permanent in acid and neutral solutions and adapted to the purpose. It is described in METALLURGICAL & CHEMICAL ENGINEERING, May, 1915, pages 336-338, and is manufactured and sold by the General Filtration Co. It is not suitable for use in strong alkalis; but organic electrolytic operations involving the use of any other kind of solvent need not be unsuccessful through lack of a suitable diaphragm.

SOME SUGGESTED ORGANIC ELECTROSYNTHESES

Approximately 150 patents have been granted, most of them prior to 1910, for electrochemical processes producing organic compounds. The bulk of these are German patents, which fact alone tends to indicate the interest in Germany in this line. A list of a few of these and other suggested organic compounds will be sufficient for the purpose of this paper; but in preparing the list it has not been restricted to preparations of known or proved commercial practicability.

With this understanding it might be said that the following offer some possibilities: Alcohols, aldehydes and ketones of fatty acids, iodoform, vanillin, chloral, azo and hydrazo compounds, oxidation products of fusel oils, dyestuffs of the triphenylmethane type, aniline blue, aniline black, Hofmann's violet, anthraquinone, alizarine, congo red, orange II, sulpho acids, piperidine, dihydroquinoline, benzidine, amidophenol, chlorbenzols, quinone, hydroquinone, saccharine and phthalic acid.

STATUS OF THE INDUSTRY

The technology of organic electrochemistry has, of course, reached its greatest development in Germany, as a natural consequence of Germany's attention to the organic field. The great secrecy maintained there in this line has made it impossible to obtain exact knowledge regarding the status of the industry. It has been stated on good authority that chloral, vanillin, iodoform, azo and hydrazo compounds have been profitably manufactured electrochemically and that one concern at least was, prior to the war, operating a large electrochemical plant devoted to the production of anthraquinone.

In Switzerland, according to my information, at least one electrolytic plant has been engaged in the production of chloroform, chloral and phosphorous chlorides, and has been utilizing electrolytic chlorine in the manufacture of synthetic indigo.

If there have been any extensive developments in this country they have escaped my attention, excepting the use of electrolytic chlorine for the indirect production of monochlorbenzol and dichlorbenzol and similar organic compounds. As already stated, I myself have made several tons of photographic developers electrochemically in the last few years and have produced hydroquinone and anthraquinone on a small-factory scale.

One of the greatest obstacles to the progress of the industry has been the scepticism of manufacturers and financiers regarding the possibilities. That, however, is nothing unusual, for it was not many years ago that the manufacture of steel in the electric furnace was ridiculed by both manufacturers and technologists. The next ten years or so will witness a development of the organic electrochemical industry which will surprise many, for, as has been shown in this paper, the underlying economic principles are favorable.

Cotton Consumption During Fiscal Years 1918 and 1919

The consumption of cotton during the year ended July 31, 1919, was 5,767,519 bales, against 6,566,489 bales during the previous year. Linters consumed amounted to 455,337 bales in 1919 and 1,118,840 bales in 1918.

Imports of foreign cotton during July were 19,408 bales of 500 lb. in 1919 and 25,002 bales in 1918. Imports for the year ended July 31 reached 201,586 bales in 1919 and 221,216 bales in 1918.

The exports of domestic cotton and linters during July, 1919, amounted to 528,902 bales, against 218,877 bales in July, 1918. The total export for the twelve months ended July 31, 1919, was 5,605,736 bales, against 4,476,124 bales for the previous year. These figures include 1879 bales of linters exported during July in 1919 and 16,802 bales in 1918 and 71,534 bales for the year ended July 31 in 1919 and 187,704 bales in 1918.—*Fortnightly Information Review, Nov. 1, 1919.*

---

[4] *Trans.*, A. E. S., vol. 32 (1917) pp. 459-462.

[5] *Zeit. f. Phys. Chem.*, vol. 45, pp. 225-230; vol. 47 (1909), p. 687; *Electrochemical Industry* (Now MET. & CHEM. ENG.), 1904, pp. 452-454.

Stretched Wire Apparatus for Measuring Thermal Expansions

By Arthur W. Gray

DETERMINATIONS of linear thermal expansivity involve:

(1) Production of temperature uniformity.
(2) Determination of temperature.
(3) Measurement of small length changes.

Of these, the last is by far the most difficult.

Difficulties in Making Reliable Measurements

The difficulties that arise in connection with the measurement of length changes are of two kinds:

First, the displacements are generally so small that in order to attain even moderate percentage accuracy, high absolute accuracy is necessary. It is comparatively easy to arrange devices of sensitivity sufficient to indicate displacements smaller than one-tenth of a micron; but it is not quite so easy to attain such precision upon repeated attempts to measure the same length. It is not at all easy to make sure that such precision, when attained, represents real accuracy, that is to say, correctness.

In the second place, measurements of thermal expansions are far more difficult than ordinary length measurements requiring the same degree of accuracy. The very nature of the case demands that the body under investigation be measured at several different temperatures; and changes of temperature are always accompanied by displacements in various parts of the measuring apparatus. Unless special precautions are taken, these displacements give rise to errors which are always difficult, and often quite impossible, to determine with certainty. So-called compensating devices are generally unreliable. Rather than trust them when accuracy is of importance, it is better to design apparatus which will render the errors negligible, or at least will make them determinable with certainty.

It was for the reasons just given that the writer introduced the use of stretched wires in 1911 when designing for the Bureau of Standards the equipment still used in determining the thermal expansivity of materials in the form of bars.

Stretched Wire Method for Measuring Linear Displacements

With the aid of such a simple device as a tightly stretched fine wire it is fairly easy to measure with great accuracy a displacement which occurs within a region otherwise difficult of access.[1]

Apparatus on this principle has been employed for the past eight years in the determination of thermal expansions. Two such arrangements of stretched wires are represented diagrammatically by Figs. 1 and 2. In each the expanding bar is indicated by *AB*. In Fig. 1, wires are freely suspended in contact with the ends of the bar and are stretched vertically by the weight of vanes immersed in oil, the viscosity of which is adjusted to damp any swinging of the wires so that their motions will be almost, but not quite, aperiodic. In Fig. 2, suitable for cases in which the bar is immersed in a liquid, wires are stretched upward to another bar *CD* rigidly connected with the central portion of *AB*. In both arrangements the transverse motions of the wires are observed through micrometer microscopes focused at convenient points *E* and *F*. Disturbances from changes in level are avoided by grinding ends of *AB* to form portions of a horizontal cylinder, the axis of which passes through the center of the bar.

Accuracy and Range of the Method

Unless one has had actual experience with this method of rendering displacements accessible to measurement, it is difficult to believe the accuracy attainable when proper precautions are taken. Thousands of observations have convinced me that the method is the most reliable yet devised for the measurement of thermal expansions. I have used the arrangement of Fig. 2 in an oil bath maintained at any desired temperature from near —150 deg. C. up to +350 deg. C., and I have used the arrangement of Fig. 1 in an electric furnace at various temperatures up to about 650 deg. C. I have not personally tested the method at temperatures much above 650 deg. C. Sufficiently fine wires of nichrome or other non-oxidizable material strong enough at higher temperatures to sustain the weights of the damping vanes were not obtainable while I was at the Bureau of Standards. Nor were my arrangements completed for an atmosphere within the furnace which would permit the use of tungsten wires. Recently, however, Dr. Souder, who is now in charge of the Expansion Laboratory, informed me that the Bureau had obtained fine enough wires of a nickel-chromium alloy which, even in air, remained sufficiently strong at temperatures up to 1000 deg. C. Tungsten, if protected from oxidation, could probably be used up to 1400 deg. C., or perhaps even higher.[2]

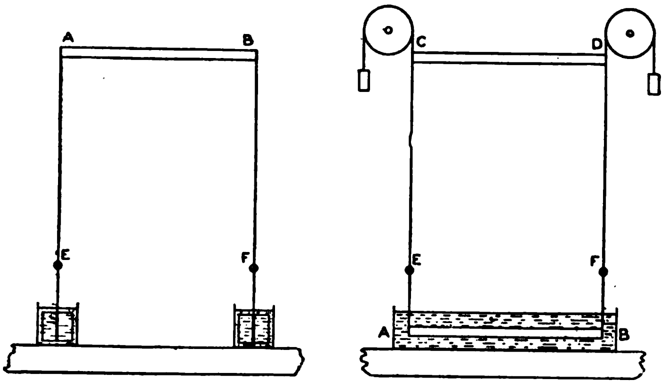


FIG. 1 & 2. DIAGRAM OF STRETCHED WIRE DILATOMETER

The stretched wire method of measuring expansions has not yet been tried at temperatures below —150 deg. C., because suitable temperature baths have not been conveniently available. The pentane which was used for the bath liquid becomes so viscous when cooled to near —150 deg. C. that proper circulation is no longer possible. It would, however, be a simple matter to modify the apparatus so as to use a bath of liquid air; and, with such refrigerating facilities as are available in the Cryogenic Laboratory of Kamerlingh Onnes, the wire method could be used down to the very lowest temperatures producible with the aid of liquefied helium. It is merely a question of sufficient refrigeration and a suitable container for the bath.

---

[1] Expansion measurements by this method were reported to the American Physical Society at the Washington meeting in December, 1911, and at various times since then. (A. W. Gray: "A New Type of Apparatus for Measuring Linear Expansion," *Phys. Rev.*, vol. 34, p. 139, 1912.) The principle of the method was also described in a communication to the Washington Academy of Sciences. ("New Methods for Displacement Measurements and Temperature Uniformity Applied to the Determination of Linear Expansivity," *Journ.*, Wash. Acad. Sc., vol. 2, p. 248, 1912.) See also "Production of Temperature Uniformity in an Electric Furnace," Bull. Bureau of Standards, vol. 10, p. 451, 1914; Scientific Paper No. 219.

[2] Jeffries recently found the equi-cohesive temperature of platinum to lie between 525 and 550 deg. C. This explains why I could not get platinum wire to sustain continuously the weights of even very light damping vanes when the temperature rose much above 600 deg. C. Jeffries found the equi-cohesive temperature of tungsten to be about 1350 deg. C. (Zay Jeffries: "The Amorphous Metal Hypothesis and Equi-Cohesive Temperatures," *Journ.*, Am. Inst. Metals, vol. 11, pp. 300-328, 1917.)

The complete equipment which I planned for the Bureau of Standards has never been finished, and consequently has not been described; but some accounts of measurements made with this apparatus at various temperatures ranging from below —140 deg. C. to above 600 deg. C. have recently been published by my former assistants Schad and Hidnert, by Merica and Schad, and by Price and Davidson.[3]

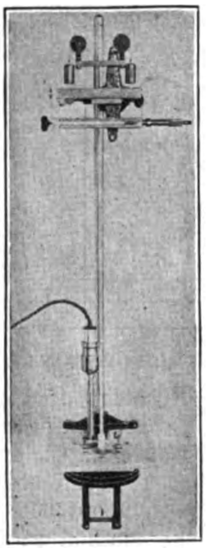


FIG. 3. DILATOMETER WITHOUT HEATING BATH

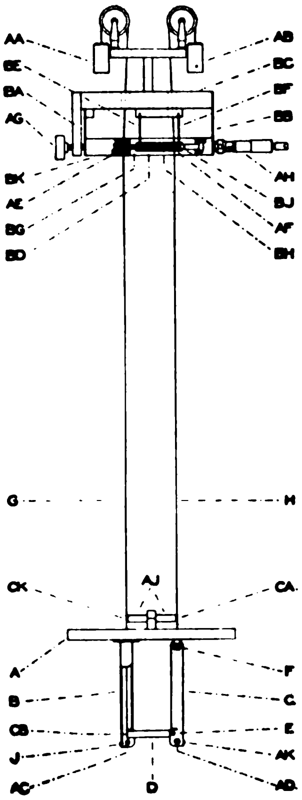


FIG. 4. SKETCH OF ESSENTIAL PARTS OF DILATOMETER

The data contained in these papers, some of which are presented graphically, illustrate the performance of stretched wire expansion apparatus under conditions of ordinary routine tests. The precision is most clearly shown by Schad's and Hidnert's measurements of the expansivity of molybdenum. They found that all their length observations made at temperatures ranging from —142.5 deg. to +18.7 deg. C. were expressible by a quadratic equation with such precision that the probable error of a single observation was ±2.6 microns per meter. Likewise, the probable error of a single observation on heating from 18.7 to 305.3 deg. C. was found to be ±2.5 microns per meter. Since the specimen tested was only 20 cm. long, these values indicate that the probable error in making a single expansion measurement was about ±0.5 micron. Moreover, a second set of observations from room temperature to 304 deg. C., taken several days later, yielded an equation which agreed so closely with that obtained during the first test that the lengths determined from the two equations did not differ by more than 4 microns per meter, or 0.8 micron in the length actually measured. Some of the slight differences observable between heating and cooling curves, and between curves obtained from different tests of the same specimen, are due to the fact that no solid has yet been found which assumes exactly the same dimensions every time it is brought to the same temperature. Molybdenum repeats better than most substances, and is, therefore, well suited for ex- expansion apparatus is also well illustrated by the is useful not only for adjusting observations, but also be seen by examining the deviation curves published by Merica and Schad.[4]

SIMPLE STRETCHED WIRE DILATOMETER

While the equipment developed at the Bureau of Standards is very efficient for the accurate investigation of thermal expansivity over a wide temperature range, it is more elaborate than is necessary for most scientific or industrial purposes. A simple but reliable dilatometer which the writer made from material to be found in almost any physical laboratory may therefore be of sufficient interest to warrant a more detailed description than that already published.[5] The apparatus, which uses the stretched wire method of measuring linear displacements, could easily be adapted for commercial testing. It differs from the precision apparatus at the Bureau of Standards mainly in the substitution of an ordinary Brown & Sharpe micrometer screw for the expensive microscope comparator and reference bar. Fig. 3 is a photograph of the dilatometer without the oil-bath for heating the specimen under test. Fig. 4 is a somewhat diagrammatic vertical projection partly in section. Minor constructional details are not represented in order that the essentials may stand out more clearly.

DETAILED DESCRIPTION OF SIMPLIFIED APPARATUS

Extending vertically downward from the cover *A* of the temperature bath made of asbestos wood are two tubes *B* and *C*, the axes of which are separated by approximately the length of the specimen *D*. At the lower end of each tube are two pointed co-axial screws *E* for clamping *D* from opposite sides. One of the tubes, *B*, is rigidly attached to the cover *A*; the other, *C*, is hinged at *F* so as to permit free expansion of the specimen. Fine wires, *G* and *H*, of annealed tungsten, clamped to the lower ends of the tubes by means of the screws *J* and *AK*, extend vertically upward through the tubes and the cover for several decimeters above the latter, where they pass over pulleys and support weights *AA* and *AB*, which keep them tight and straight. The pins *AC* and *AD* cause the wires to bear firmly against the rounded ends of the specimen *D*. Small circumferential V-grooves in these pins center the wires and prevent them from slipping across the ends of the specimen.

---

[3] L. W. Schad and Peter Hidnert: "Preliminary Determination of the Thermal Expansion of Molybdenum," Bull. Bur. Standards, vol. 15, pp. 31-40, 1919. P. D. Merica and L. W. Schad: "Thermal Expansion of Alpha and of Beta Brass between 0 and 600 deg. C., in Relation to the Mechanical Properties of Heterogeneous Brasses of the Muntz Metal Type," *Journ.*, Am. Inst. Metals, vol. 11, pp. 396-407, 1917; Bull. Bur. Standards, vol. 14, pp. 571-590, 1918. W. B. Price and Philip Davidson: "Physical Tests on Common High Brass Taken Parallel and at Right Angles to the Direction of Rolling-Appendix," *Trans.*, Am. Inst. Metals, vol. 10, 1916.

The expansion determinations reported by Price and Davidson were planned in detail by the present writer; the measurements and charts were made by Messrs. Schad and Hidnert; the specimens of brass were furnished by Mr. Price.

[4] In specifying the accuracy of the method, Merica and Schad (*Journ.*, Am. Inst. Metals, vol. 11, 1917, p. 399; Bull. Bur. Stand., vol. 14, 1918, p. 577) state: "The length changes measured in this way are accurate to about ± 0.001 mm., which on a specimen of 300 mm. long (the standard length of the specimen) would be ± 0.0003 per cent." The last part of this statement, however, is misleading, because percentage accuracy in expansion measurements should be expressed as a certain per cent not of the length of the specimen, but of the elongation measured. This will depend not only upon the accuracy of the apparatus and upon the length of the specimen, but also upon the expansivity of the latter and upon the temperature range employed. Since apparatus using a given method of determining thermal expansivity can usually be constructed to accommodate specimens of any convenient length, the essential elements that should enter into a description of the accuracy obtainable by a particular type of apparatus are absolute accuracy in the measurement of elongations and absolute accuracy in the production and the determination of uniform temperatures.

[5] Abstract of a paper presented at the Baltimore meeting of the American Physical Society. *Phys. Rev.* vol. 13, p. 142, 1919.

At the upper end of the apparatus are two smooth round pins *AE* and *AF*, which bear against the wires *G* and *H*, a decimeter or so below the pulleys. By means of the screws *AG* and *AH* these pins move horizontally in the plane of the wires, so that the upper portions of these wires can be brought closer together or separated a measured distance.

Just above the cover of the temperature bath is placed a horizontal bar *AJ*, of low and known thermal expansivity, protected as far as possible from temperature changes accompanying warming and cooling of the bath below.

This bath, which is not shown in the illustrations, is of oil, heated electrically, and continuously stirred by a screw propeller, the containing tank being provided with suitable guides for insuring thorough mixing and circulation. If air is excluded to prevent flashing, "Renown" engine oil can be used to over 300 deg. C. Pentane gasoline remains sufficiently fluid down to about —150 deg. C. Although these two liquids will cover the entire range, kerosene is usually the most convenient substance when measurements do not have to be extended much beyond either 0 deg. or 75 deg.

After the specimen has been placed in the heating bath and temperature equilibrium has been reached, the upper end of each stretched wire is moved until the wire just touches the end of the bar *AJ*. Contact is indicated electrically by means of an inexpensive reflecting galvanometer in series with a dry cell and a suitable resistance. As the specimen *D* expands, it moves the wires away from the contact bar *AJ*. The magnitude of the expansion is determined from the movements of the screws *AG* and *AH* required to restore contact.

Only one graduated screw is actually used. The ordinary screw *AG*, of moderately fine pitch, moves a horizontal bar *BK*, to which are rigidly attached both the pin *AE*, which communicates the motion to the left-hand wire *G*, and the nut of the graduated screw *AH*, which moves the right-hand wire *H*. In this way a single micrometer screw is made to measure the total displacement of both wires. A Brown & Sharpe micrometer head is convenient for this purpose.

The movement of the bar *BK* is guided without lost motion by means of the thin flat strips of spring metal *BA* and *BB*, which suspend it from the bar *BC*. The smaller bar *BD*, which carries the pin *AF*, is likewise supported by the flexible strips *BE* and *BF* so that it is freely movable horizontally within a rectangular cavity cut through the central portion of *BK*. The spiral spring *BG* surrounding the rod *BH* presses *BD* firmly against the end of the measuring screw *AH*. The steel ball *BJ*, pressed tightly into the end of *BD*, makes an excellent bearing for the end of the screw.

The bar *AJ* is merely a piece of Pyrex glass tubing. (Fused quartz, because of its still smaller thermal expansivity, would be better.) Bearing firmly against each end of the tube, a tungsten wire (*CK* and *CA*) about 0.1 mm. in diameter is tightly stretched horizontally between two posts, one of which serves to connect the wire electrically with the galvanometer for detecting contact with the adjacent vertically stretched measuring wire. These posts, which may be ordinary machine screws with nuts, are not represented in Fig. 4, but are visible in Fig. 3. The ends of the tube are, of course, suitably ground so that the horizontal wires will be parallel to each other, and so that there will be no interference with the motions of the vertical wires. The horizontal wires define the effective length of the contact bar *AJ*.

PREPARATION OF SPECIMENS FOR TESTING

The preparation of a specimen for an expansivity determination is an easy matter. All that is necessary is to cut off a rod of the required length and to round the ends smoothly, so that they form portions of a cylindrical surface. The rounding should, however, be accurately done, since its purpose is to prevent small angular displacements in the plane of the wires, causing errors by changing the distance between contacts. The easiest and best way of producing the cylindrical surfaces is by grinding.

Fig. 5 illustrates a simple tool for holding a specimen during this operation. By means of radial screws near each end the rod is firmly clamped within a metal tube. Midway between its ends this tube is pivoted between two co-axial pointed screws which hold it within the arms of a forked bar of rectangular cross-section. As the bar is gradually advanced toward the edge of the grinding wheel, the tube containing the specimen is rotated between the pivot screws of the fork.

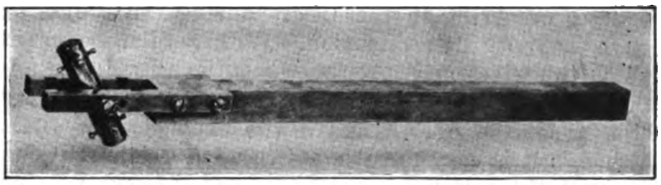


FIG. 5. FIXTURE FOR GRINDING TEST SPECIMEN

A screw-operated slide-rest is not at all necessary for feeding the specimen toward the grinding wheel. With the exercise of a little care the movement can be sufficiently well guided by pressing one corner of the forked bar into the dihedral angle of a support formed by fastening a straight strip of wood or metal upon a flat surface. The bar is advanced toward the wheel by gentle tapping against the farther end. Even glass can be ground in this way without difficulty.

Near each end of the tube which holds the specimen during grinding are two small holes, one from each side. These form convenient guides for drilling the little conical depressions or holes (*CB*, Fig. 4) that receive the pointed ends of the clamping screws *E*.

SOURCES OF ERROR

The accuracy of the simple dilatometer described above is limited mainly by the accuracy with which contact can be detected between the stretched wires and the bar *AJ* above the temperature bath. Immediately before taking a series of readings the contact surfaces of both the wires and the bar should be washed with a little ether applied by means of a camel's hair brush. With delicate touch the left-hand screw *AG* is then cautiously and steadily turned until the galvanometer gives the first slight indication of contact between the wire *G* and the end of the contact bar *AJ*. A small deflection that increases with continued advance of the screw indicates a better contact than a sudden, large deflection. After contact has been established with the left-hand wire, the measuring screw *AH* is advanced until the right-hand wire *H* makes contact with *AJ*. At each temperature or measurement, settings of both screws should be repeated a sufficient number of times to make sure that good contacts are being obtained. Failure to obtain a series of concordant readings is evidence that something is wrong—probably a dirty contact or lack of care in turning one of the screws.

The effect of errors in the measuring screw varies inversely as the ratio of the distances from the contact bar *AJ* to the pins *AE* and *AF* for moving the wires and to the specimen *D*. In the apparatus actually used these pins were 600 mm. above and the specimen 150 mm. below the bar, so that the micrometer screw *AH* measured four times the expansion of the specimen. The results showed that with proper use deviations of individual screw readings from the average should not exceed 5 microns. The average deviation of 107 individual readings from the average reading for each temperature was less than 2 microns, corresponding to an average deviation of 0.5 micron in determining the expansion of the specimen.

Corrections must be applied on account of length changes in *AJ* and in *BK* brought about by temperature changes occurring in these bars during the course of an expansivity determination. With a dilatometer in which the wires multiply the elongations by 4, the apparent expansion of the specimen must be corrected by the expansion of *AJ* and ¼ the expansion of *BK*. Although it is easy to calculate these corrections if the expansivities and the temperatures of *AJ* and *BK* are known, it is more convenient to render the corrections negligible, or at least very small, both by using materials of low expansivity for these parts of the apparatus and by protecting them from temperature changes—especially changes caused by convection, conduction and radiation from the bath for heating the specimen under test.

CONCRETE ILLUSTRATION OF AN EXPANSIVE DETERMINATION

A concrete example illustrating the capabilities of the above-described simple apparatus is afforded by a determination of the thermal expansivity of some optical glass.*

A summary of the measurements made is contained in the accompanying table. In this table Column A gives in degrees Centigrade the temperatures of the oil bath in which the specimen was heated. These temperatures were determined by means of the platinum resistance thermometer visible in Fig. 3. The mercurial thermometer also shown was used merely as a rough indicator. Column B gives in microns the expansion of the specimen observed on heating it from 23.45 deg. to each temperature recorded in Column A. In obtaining these values the corrections given in Column D were added to the apparent expansions indicated by the measuring screw. For calculating the corrections the linear expansivities of the brass bar *BK* and of the Pyrex glass tube *AJ* were assumed to be 0.000018 and 0.0000032 per degree Centigrade, respectively. The magnitudes of these corrections could have been greatly reduced by proper choice of materials together with proper thermal insulation.

The precision attained in measuring the expansions is indicated by Column C, which gives opposite each temperature the average deviation in microns of the individual indications of the measuring screw from the average value observed at that temperature. The deviations here recorded, which correspond to elongation of the specimen under measurement, were obtained by dividing the corresponding deviations of the actual screw readings by 4, since the stretched wires multiplied the specimen elongations by 4. Column E shows the number of micrometer screw observations that were averaged at each temperature to obtain the values under B and C. Examination of the table shows that, for the 107 contact observations represented, the average deviation was only about 0.46 micron. This gives some idea of the high precision attainable with a stretched wire dilatometer even when the construction is as crude as that pictured in Fig. 3, which is a photograph of the apparatus actually used for obtaining these results.

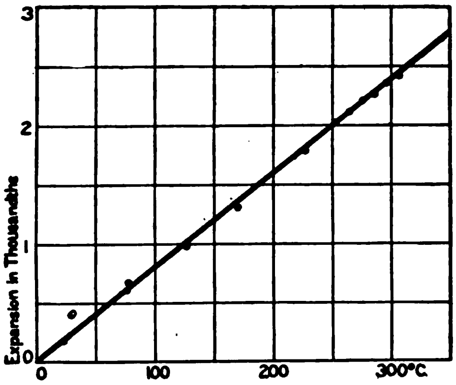


FIG. 6. THERMAL EXPANSION OF OPTICAL GLASS

THERMAL EXPANSION OF OPTICAL GLASS

A	B	C	D	E
23.45	0.0	±0.5	—2.8	7
77.51	25.5	0.6	—2.5	3
78.21	29.2	0.4	—1.0	8
127.24	47.2	0.4	+0.2	9
170.55	67.2	0.2	+2.0	6
227.83	95.8	0.3	+3.0	10
254.13	110.0	0.6	+3.2	9
265.75	115.5	0.5	+3.0	7
276.62	120.8	0.5	+3.0	9
286.39	124.2	0.4	+4.0	9
297.07	130.0	0.6	+4.5	6
307.81	133.5	0.4	+5.8	7
30.85	13.8	0.6	—2.0	7
29.96	13.0	0.5	—1.2	10

A. Temperature Centigrade.
B. Expansion in microns of 6 cm. specimen.
C. Average deviation in microns from average.
D. Correction in microns for temperature changes in apparatus.
E. Number of micrometer screw settings averaged.

A plot representing the observations recorded in the table is shown in Fig. 6. The straight line corresponds to an expansivity of 0.00000794 per degree Centigrade. The last two observations, which were made the day following the observation near 308 deg., are represented by the open circles. Such failure of a glass to return to its original length upon cooling after strong heating is frequently observed.

---

*At the request of Dr. Arthur L. Day, Optical Glass Committee, War Industries Board, the writer undertook to determine the expansivity of this glass, which had been produced under the direction of the former for naval searchlight mirrors. The dilatometer pictured in Fig. 3 was hastily designed and constructed especially for this work.

Although Fig. 6 indicates an accuracy sufficient for most scientific or industrial purposes, it should be borne in mind that the specimen tested was only 60 mm. long and that the corrections given in Column D of the table are both considerably larger and considerably more uncertain than need be. If the errors involved in the corrections be rendered negligible by the means indicated above, the relative accuracy of the expansion measurements will be increased in the same ratio as the length of the specimen under test is increased, since the deviations in Column C represent absolute, not relative, precision in length measurement.

VARIATIONS OF THE STRETCHED WIRE DILATOMETER

The apparatus actually constructed as outlined above illustrates merely one particular arrangement for applying the general principles of the stretched wire method. It was hastily designed and built to meet an emergency. Various details could obviously be modified. For example, two independent graduated screws for moving the stretched wires *G* and *H* would be a convenience; any sensitive detector of contact is usable; tungsten wires are not necessary, etc. Moreover, micrometer screws can be arranged to replace microscopes for use with either an air bath (as in an electric furnace) or a liquid bath; so that the range of application even in the simplified form of dilatometer is not limited to the interval between room temperature and 300 deg. C.

Nor is the application of the stretched wire method limited to the case of thermal expansion. The writer has already used wires for measuring magnetostriction in nickel steels at temperatures ranging from —75 deg. to +300 deg. C.[7] Wires could easily be adapted to the construction of an extensometer for measuring deformations of materials during any kind of testing, especially when it was desired to control the temperature of the test piece. In fact, there appears to be no other method that is quite so reliable for accurately following linear displacements that occur in regions which are difficult of access.

Physical Research Laboratory,
The L. D. Caulk Company,
Milford, Del.

The Magnesite Industry in Austria

THOUGH the term "magnesite" is generally applied to the iron-bearing carbonate of magnesium, such is is found in Austria and Hungary, by some Austrian magnesite is referred to as bruennerite. The mineral bruennerite has become of commercial importance only in Austria. The important deposits are found in Styria, lower Austria and northern Hun-($FeCO_3$), occurs at Eisenerz, Styria, while the world's largest deposit of spathic iron ore, or iron carbonate ($FeCO^3$), occurs at Eisenerz, Styria, while the world's largest deposit of spathic bruennerite is found at Veitsch, in the same province.

The Styrian and lower Austrian deposits are located much nearer the Adriatic Sea than are the deposits of northern Hungary; and it is from the former that most of the exported magnesite has come. They are located southwest of Vienna, and extend west from Semmering through the Murz Valley to Tyrol. The chief deposits reckoning from east to west are those of Semmering, Veitsch, Breitenau, Trieben, Radenthein and Dienten.

The largest and most important deposit is that at Veitsch, located near Mitterdorf, on the South Austrian Railroad in the Murz Valley, Styria. Here the magnesite, which occurs in the form of a lens, is quarried on the slope of a hill in a series of terraces about 50 ft. apart. The entire work extends through a vertical distance of 500 ft. The huge magnesite lens is nearly ¾ of a mile long and over 1000 ft. in width, and probably extends to a considerable depth.

The formation containing the magnesite extends where magnesite is quarried beyond Jolsva and Nyustya, in the Gomer district. In spite of the remote location of these deposits as compared with those in Styria, magnesite was shipped from them before the war a distance of 360 mi. to the port of Fiume for overseas shipments to other parts of Europe and to America.

The average analysis showing the composition of the mineral found in Austria-Hungary is as follows:

	Per Cent		Per Cent
Magnesia	33 to 44	Silica	1 to 5
Lime	1 to 3	Carbon dioxide	50
Ferrous oxide and alumina	2 to 7	Water	......

CHARACTER OF THE SINTERED PRODUCT

The magnesite occurs as lenticular masses in a belt of carboniferous rocks consisting mainly of metamorphosed shales, sandstones, conglomerates and limestone. It is grayish in color when fresh, and contains sufficient ferrous carbonate to blacken it when calcined. It turns brown owing to the oxidation of the ferrous carbonate when exposed to the air. The quantity of carbonate of iron is variable and different analyses show that it ranges up to 13 or 14 per cent.

For the most part, only the sintered article has been imported into the United States. This material has achieved an enviable reputation for its uniformity both as to chemical and physical characteristics. The homogeneity of the sintered Austrian magnesite is doubtless due in part to the averaging effect of the different operations, such as crushing, dressing, sintering and mixing, an effect which is not obtainable in mere hand samples.

There is comparatively little variability in the sintered magnesite as marketed, and five analyses of this sintered magnesite as quoted by Cornu[1] are as follows:

	Per Cent
Magnesia (MgO)	85.53 to 90.07
Lime (CaO)	0.96 to 3.52
Ferrous oxide (Fe_2O_3)	7.43 to 9.96
Alumina (Al_2O_3)	0.00 to 2.22
Manganese oxide (Mn_2O_4)	0.51 to 0.76
Silica (SiO)	0.26 to 1.34

QUARRYING AND PREPARATION

The methods of quarrying and preparing magnesite in Austria and Hungary are similar at most of the different plants. On the outskirts of the village of Veitsch, about 56 mi. southwest of Vienna, is found one of the largest deposits, and one which has been worked the longest. Since the methods of mining and preparation here are fairly typical, they will be outlined.

---

[1] F. Cornu, *Z. Prakt. Geol.*, 1908.

[7] A. W. Gray, D. H. Sweet and L. W. Schad: "Some Effects of Magnetization on the Length of a 35.25 Per Cent Nickel Steel," *Phys. Rev.*, vol. 7, p. 684, 1916.

As stated above, the magnesite quarry at Veitsch is worked in a series of steps or levels about 50 ft. apart vertically. The material is blasted out of the solid by the ordinary methods of rock quarrying. It is next broken in pieces which can be handled readily by one man, and the dolomite and quartz are carefully picked out. Even in the best of the deposit, there is a large quantity of this gangue material, and estimates of the waste rock vary from 50 to 66⅔ per cent of all the material quarried. Terrace quarrying and working conditions in general like these at Veitsch are practiced at Breitenau and at Eichberg.

The coarse quarried material is cobbed to free it as far as possible from impurities like chist, dolomite and quartz, and the lumps are sorted. The cleaner portions of the magnesite are reduced to pieces about the size of a man's head. Less pure portions have to be broken into pieces about the size of a man's fist. These dressing operations involve a considerable loss of magnesite in the form of small fragments, too small to be burned in shaft kilns. The raw material thus obtained in the quarries at Veitsch is transported by gravity planes to the sintering kilns at the foot of the hill.

SINTERING TEMPERATURE

According to Morganroth,[3] continuous kilns of the bottle variety are used and producer gas is employed as fuel. These kilns burn on an average of 15 to 24 tons of calcines per 24-hr. day. Within the last few years, a few plants have installed rotary kilns of the cement type to burn the magnesite, powdered coal being used as fuel. The capacity of these kilns is 50 to 60 tons per 24-hr. The magnesite can be burned as thoroughly in these kilns as in the bottle kilns, but they have one disadvantage in that a larger per cent of fines is produced. The magnesite as burned in the bottle kiln is drawn every 6 hours.

The sintering temperature varies from 1500 deg. C. (2350 deg. F.) for bruennerite containing considerable iron oxide to 1700 deg. C. (3100 deg. F.) for material poor in iron oxide. However easily the material sinters, it appears desirable to carry the temperature up to at least 1500 deg. C. (2700 deg. F.), but this temperature seems to be exceeded, as a rule, in the shaft kilns in Styria.

TREATMENT OF THE CRUSHED SINTER

The magnesite, after being drawn from the kilns, is quenched with water and crushed to walnut size or less. It is then classified mechanically by screening or sizing into three different sizes. Much of the caustic lime or calcined dolomite is removed in the first screening owing to its finely divided condition. From the screens it goes to the picking tables, where the underburned magnesite, together with the dolomite and quartz, present in particles too small to have been removed at the quarries, is picked out. These are light colored, and consequently readily distinguishable. The magnesite in the larger sizes is again crushed and the smaller pieces repicked. The magnesite is finally crushed to the size of kernels of corn, picked over again, and sacked for the trade in packages of 150 to 200 lb. each.

In recent years, magnetic separators have been introduced which have resulted in an economy in the picking or sorting operation. If not magnetically treated, the finely divided material marketed would necessarily contain particles of schist, quartz or other non-magnetic minerals. It must be said, however, that the magnetic treatment involves some waste, since only magnesite containing iron is removable by this treatment. It adds to the expense and is presumably employed only when it is necessary to obtain a concentrated, uniform and most highly refractory product.

In addition to the milling and sintering plant at Veitsch, where operations are as outlined above, there are other localities in Styria where work is done in a similar manner, for example at Breitenau, Trieben and in lower Austria at Eichberg, near Gloggnitz.

FUEL REQUIRED

The amount of fuel required to sinter Austrian magnesite varies and is dependent in part on the quantity of the ferrous carbonate present. With good flaing brown coal, having a heating value of 6000 calories, the quantity required varies from 600 to 800 lb. per ton of sintered magnesite. The fuel requirement has been estimated by others at 1000 lb. per ton of sintered magnesite produced. The latter coal, however, has a calorific value of only 4000.

The abundance and accessibility of the brown coal used in sintering Austrian magnesite has been a very important factor in the cheapness of past production.

OTHER COMMERCIAL CONDITIONS

At Veitsch the marketable sinter is trammed on an aërial tramway about 4 mi. long to Wartberg Station. The works at Trioben are near the station, which is located about 3 mi. from the deposit at Sunk, where the material is quarried. At Pradenthein, work was begun by American capital in 1908, and from that time till the war cut off the supply a great deal was shipped to Philadelphia, New Orleans and New York. The shipments from Europe were usually made through the port of Trieste, and before the war ocean freight per ton was $2.50.

The facts that the Austrian deposits are large and are easily quarried; that they are within easy reach of transportation facilities, and the additional fact that labor, at least before the war, was cheap have all tended to give Austrian magnesite commercial supremacy in the world's markets. These conditions, moreover, help to explain the success which Austrian magnesite has achieved in the past and indicate the possibility of the competition which it may be able to exert in the future. Only the massive deposits of the Veitsch type can be quarried and worked at a profit, however, and some of the larger deposits, not well located, have been unable to compete in the past.

---

[3] *Bulletin*, American Institute of Mining Engineers, No. 93, 1914, pp. 2345-2452.

Melting of Some Non-Ferrous Metals and Their Alloys in Electric Furnace

Requirements for Economic Melting of Non-Ferrous Metals and Their Alloys—Adaptability of a Contact Arc Resistance Type Furnace—Melting Cost in Electric vs. Fuel-Fired Furnaces—Sources of Losses—Tabulated Data

BY E. F. COLLINS

SATISFACTORY and economical melting of non-ferrous metals and alloys requires a furnace of the following specifications:

Dependability and continuity of operation.

Freedom from oxidization of metals or alloys while in the furnace; in fact, deoxidation of metals or alloys in some degree is usually advantageous.

Freedom from volatilization of metals should exist subsequent to their liquefication and while in the molten state, to prevent loss of metal in the form of escaping vapor, which usually oxidizes upon its escape from furnace to air, when the furnace atmosphere is neutral or reducing, i.e., free from oxygen.

FREEDOM FROM SLAGS

The slags, which are due to overheated linings, dirt from scrap, oxides from metals, etc., should not mix with the melted metal. This allows of dry skimming (during melting) of dirt, sand and other impurities, without entrained metal in the form of shot in the fused slag, that must subsequently be crushed and the metal reclaimed by more or less elaborate process. The furnace should not require the maintenance of an elaborate and expensive reclaiming plant. In other words, impurities should float on top of the bath in the furnace and allow of skimming this from the surface of the bath. It should allow of the use of sal ammoniac or other flux to aid in cleaning the metal while molten in the furnace, but should not regularly require the use of such flux to give perfect metal; neither should the bath require charcoal covering while melting or subsequently while held in furnace.

Uniformity of alloy and absence of segregation should exist when the furnace charge has reached the pouring stage, i.e., test bars should show uniform physical characteristics throughout their length, a perfect fracture, satisfactory crystallization and lack of segregation under microscopic examination.

MELTING CHAMBERS AND THEIR SIZE

The furnace linings and atmosphere must be free from the slightest degree of sulphur, and the furnace atmosphere must be controllable as regards oxygen when melting copper and many alloys rich in copper, in order to produce satisfactory foundry castings of sound metal, since copper greedily absorbes sulphur and oxygen when hot, which gives rise to trouble on cooling. In fact, furnace melting chambers should be free from contaminating influences, coupled with a controllable atmosphere with respect to oxygen, in which case electrolytic cathodes, free from salts of the electrolytic bath, may be melted down and poured "at pitch" without "rabbling and poling." This will eliminate the use of the present day reverbatory copper refining furnace and allow of making brass directly from cathode copper as well as cathode zinc, thus saving one refining operation on copper and one melting or "pigging" operation on zinc.

The melting chamber should be arranged so that its atmosphere may be reducing, neutral or oxidizing for certain metals and alloys, i.e., its oxygen should be controlled. A certain flow of gas through the furnace may be required at times and at others a "dead" or "still" atmosphere is absolutely necessary. No advantage, however, is secured in attempting to seal hermetically the furnace unless some process of distillation is attempted. Hence, if the furnace is provided with doors, it is only necessary that they close in such a manner, and are of such construction, as to prevent an undue loss of heat and circulation of gases in the furnace when they are closed. A single small opening in the furnace, such as is required for stirring the bath or pouring, may produce a sort of breathing of the furnace when the vent is open, but the loss of heat or metal is not appreciable if the furnace is being properly manipulated.

Large-capacity furnaces which do not involve the use and handling of crucibles are desirable where local conditions will permit. Large furnaces promote economy, due to higher thermal efficiency, saving floor space in proportion to metal melted, saving in labor, saving in cost of lining per ton of metal melted, especially when compared to crucible cost, their storage, drying and tempering, spill from broken crucibles, etc.

Where metal is melted in large furnaces, preheated hand ladles or crucibles are used to transfer the molten metal to molds where small foundry castings are being made, and it is important that these ladles or crucibles be well and properly preheated before using, especially when pouring small parts such as ½-in. brass valves, etc., in order to get satisfactory work. The burden of the preheated crucible is eliminated several times over by the many advantages coupled with the use of the non-crucible tilting furnace above ordinary crucible capacities.

FURNACE LININGS

Furnace linings should in the main be built of commercial refractories of moderate cost, which are at all times available, such as standard fire brick and shapes, with limited use of special refractories where the results justify their usage, rather than of special refractories, which can be procured only at high price and with more or less difficulty and uncertainty. If the foundry man or metal melter will make repairs upon his linings at least once every two weeks, and when in severe service once each week, his lining cost will be much less than when special high priced refractories are used and repairs and inspection of linings are less frequent. The refractoriness of linings should be such that they will not fuse or slag perceptibly at melting temperatures. Their inner surface should be glazed over at temperatures above the metal melting zone. This guards against slag formation during the melting process, assuming that no chemical reaction occurs between metal and hearth to reduce the fusion point of the refractories. As an illustration, the presence of lead in brass melting fluxes the refractories at temperatures at which they are immune in contact with the same bath free from lead.

HEAT DISTRIBUTION

Shallow baths promote a more uniform and rapid melting and freedom from segregation than the deep bath. The source of heat should be a uniform, mild, "soaking" heat, and its temperature gradient above the bath should be moderate; that is, due to a large absorbing surface, the bath takes in a large quantity of heat at a low heat potential. The transfer of heat to the metal is accomplished most successfully by radiation to the top of the bath and conduction to the bottom. In case the source of heat is only slightly higher than the charge when the fusing point of metal is reached, the metal may be held for an indefinite period within that zone of temperature above the fusing point in which vapor tensions are not sufficiently high to cause appreciable loss of metal from volatilization. In other words, if the source of heat is such that its temperature lies in the temperature zone safely below the destructive distillation point of the metal, then the bath can in no manner exceed it. A safe way in securing this heat control is to limit the temperature of the heat source by means of a pyrometer. Pyrometers are available at present which live for a satisfactory period in certain brass furnaces, which makes their use entirely practical. It follows from the above that furnace design should be such as to allow of the source of heat being held at any temperature desired.

The heat distribution should be fixed and if possible automatically controlled; i.e., heat received by radiation as related to that received by conduction should be such as to secure a uniform heat of the bath. If any variation in the ratio of heat radiated to top of the bath and that conducted to bottom is permissible, this variation should allow of a reduction of radiant heat at the top of the bath at once when the fusing temperature is reached, because when the bath is liquid its bottom convected heat will give uniformity of temperature to the bath.

The foregoing sets forth more or less in detail the requirements for economy in melting brass alloys. It is now desired to consider the characteristics of the electric furnace and see how completely it overcomes the obstacles met with in the fuel-fired furnaces for melting non-ferrous metals and their alloys.

CLASSIFICATION OF ELECTRIC FURNACES

Class I comprises furnaces in which heat is developed by the passage of current through a solid, laminated or granular conducting medium or resistor.

(*A*). The conducting medium may consist of material that is to be treated.

(*B*). The heat developed in the "resistor" is transferred to the charge by conduction or radiation or both; a wall may or may not intervene between the "resistor" and the charge.

(*C*). A readily controllable amount of heat is generated between a fixed and movable carbon electrode, their distance apart being maintained such that the granular carbon lying between the faces gives rise to many chains of series and multiple contact or resistance arcs, enveloping adjacent electrode faces.

Class II comprises furnaces in which heat is developed by the flow of current through a liquid or solid conductor.

(*A*). Electrolytic.

(*B*). Non-electrolytic.

Class III comprises furnaces in which heat is developed by flow of current through gas or air arc furnaces.

In the making of brass, furnaces lying in each of the three classes have been tried out. Furnaces lying in Classes I and II lend themselves readily to the generation and control of a mild, "soaking" heat such as is required for melting volatile alloys. As illustration, the common resistance furnace lies in Class I, and the induction furnace in Class II. Furnaces in Class III generate a too intense and burning heat to be used with even questionable success in melting volatile alloys without the use of much unnecessary manipulation and watchfulness requiring much skill. Control of the electric arcs in atmospheres high or low in volatile gases, freedom from surging, low power factor and high metal loss are some of the serious problems confronting the man who would melt volatile alloys in the Class III arc furnace. Their employment had best be left for steel.

ADAPTABILITY OF TYPE C RESISTANCE FURNACE

A furnace falling in Class I and Type C of the above classification has proved, upon experience gained from many tests as well as from its commercial operation in the foundry, that it is the best adapted for melting non-ferrous metals and their alloys.

Its design, construction and the reasons why it is suited to melting the non-ferrous metals and their alloys are given below somewhat in detail.

DESCRIPTION AND DESIGN OF FURNACE

An example of this type of furnace is shown in Figs. 1 and 2. It will be noticed that it consists essentially of a refractory lined case within which are located in the same chamber the heating units lying on either side of the melting hearth (3). The source of heat is 13 and lies in a duct separated from the bath by carborundum walls 5 and 6. This duct is fitted with cross electrodes 9 and with wearing blocks 12 under each of two vertical electrodes projecting through the arched roof. These cross electrodes in the bottom of the duct, as well as the wearing blocks between them and the vertical electrodes, are of carbon. The whole duct is filled with granular coke to the height of the bridge wall 5 and 6 on either side of the hearth. Neutral electrodes 16 and 17 make contact with the cross electrodes 8 and 9. These neutral electrodes are for the sake of automatic control, as will be seen later. The vertical electrode carries a water-cooled ring where it emerges from the top arch. The cable clamp for electrode 15 is also water-cooled. The two vertical electrodes 11 are terminals of one phase, while those marked 10 are terminals of another. In other words, the furnace is inherently 2-phase. By multipling the 2-phase, however, it may be operated single phase, or by using Scott transformer connections it may operate from 3-phase source. The phase voltage most satisfactory has been found to be 60 to 70 v. The detailed arrangement of the electrodes, etc., in resistor duct is evident.

The operation of the furnace in generating heat is as follows:

The current supplied to the furnace flows through the vertical electrodes 10 and 11 through a short space filled with granular carbon to the wearing block 12, into the cross electrodes 9, into second wearing block 12′ and out to line through second granular coke strata and second vertical electrode. The value of the current is regulated automatically by varying the distance between the vertical electrodes and the wearing block. In other words, by means of a current-controlled relay the distance between 11′ and 12′ is governed; also by means of a voltage-controlled relay connected to neutral bottom electrodes and vertical electrode 11. The distance between electrode 11 and wearing block 12 is held to correspond to one-half the phase voltage, i.e., 30 to 40 volts. A rheostat on the control panel allows of setting control for any current value required, and when once set for a given value, such value is held until the rheostat position is changed by the furnace operator. Hence the power input is automatically held constant and is subdivided equally between the vertical electrodes. Starting with a cold furnace the heat is generated first in the granular carbon separator lying under the bottom face of the vertical electrode. This immediately becomes incandescent by virtue of the current carried by the carbon granules, and heat is also generated by a multitude of contact arcs enveloping the lower end of the vertical electrode. Heat is at once taken from this source by the granular coke in the trench and its whole surface becomes heated to the desired point. The surface of the granular carbon radiates heat to the arched roof, and the body of granular carbon and wearing block with the cross electrodes conduct heat to the furnace walls and to the sides and bottom of the hearth with which they are in contact. Furthermore, as the furnace becomes heated a certain amount of current flows from the vertical electrode 11 to vertical electrode 11′ directly through the granular coke in a way similar to the simple carbon resistance furnace. This heat may be as much as 30 per cent of that developed locally at each vertical electrode as above described through contact arcs and resistance. This heat is largely radiated to the roof, since it is generated largely in the upper surface of the coke body. In addition to serving as enclosing wall of the furnace, the roof is so shaped that it acts also as a highly efficient reflector, throwing the heat received from the incandescent coke ducts on either side of the hearth uniformly on the hearth or bath. This heat is very uniform and what is called a mild "soaking heat," and hence lends itself well to the melting of brass or volatile metals; especially is this a fact since a part of the heat is supplied to the bath from the bottom and sides.

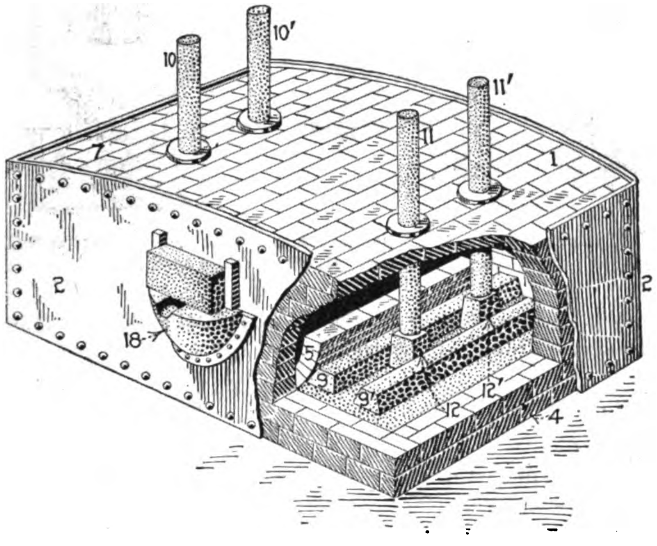


FIG. 1. SCHEMATIC VIEW CONTACT ARC RESISTANCE TYPE FURNACE

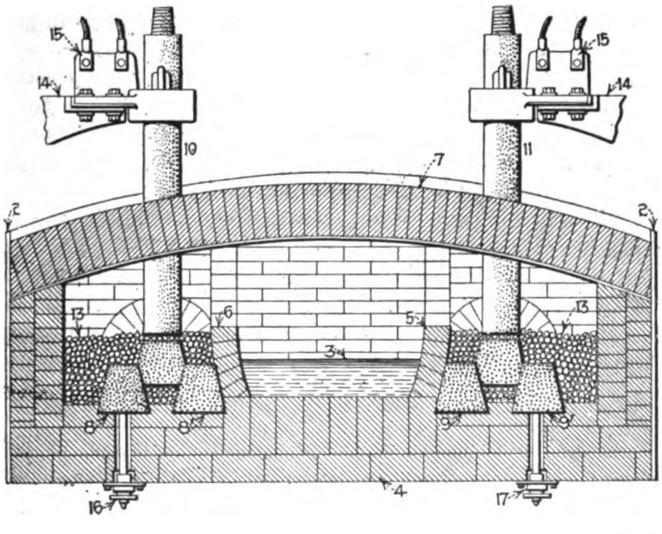


FIG. 2. SECTION OF CONTACT ARC RESISTANCE TYPE FURNACE

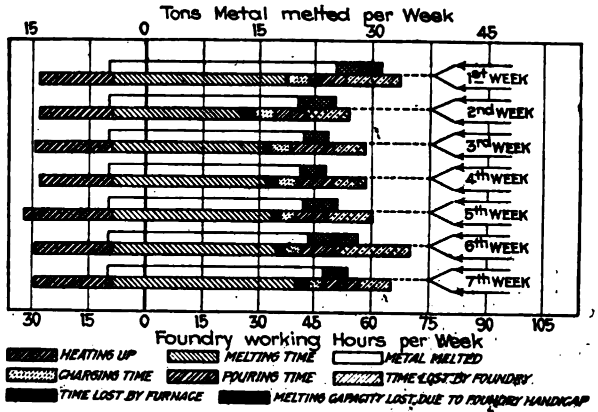


FIG. 3. CHART SHOWING CONTINUITY OF SERVICE OF ELECTRIC FURNACE MELTING BRASS IN

SOME CHARACTERISTICS OF THE FURNACE

To enumerate briefly some characteristics of the above-described furnace which makes it essentially suited to melting non-ferrous metals and their alloys, we have the following:

1. The temperature of the heat generating source is controllable at will.
2. The heat generated is of the mild "soaking" type, uniformly distributed, and any workable temperature gradient may be maintained between the charge and the heat source.
3. The heat is received by the charge from above, on the sides and through the bottom.
4. The bath is comparatively shallow and a large surface is exposed to receive the heat. (The bath depth is approximately 6 in. in a 1500-lb. furnace.)
5. The furnace has normally a reducing atmosphere, which may readily be made neutral or oxidizing.
6. Automatic control of power, requiring little attendance.
7. The furnace atmosphere is free from contaminating gases.
8. A "dead atmosphere" practically restrained from escape exists normally in the furnace.

9. The temperature is controllable, so that slags do not form in melting brass. Hence simplicity of metal recovery from the dirt skimmed from the top of the bath in the furnace.

10. The furnace may be "forced," i.e., the heat may be fed to the metal as fast as it is absorbed, and a high rate of melting results with all its advantages and with none of the disadvantages met with in fuel-fired furnaces.

11. Dependability of furnace and continuity of operation under commercial conditions as illustrated in Fig. 3. The delays due to the furnace are of short duration when compared to the time the furnace was delayed due to foundry conditions; in other words, little melting capacity was lost and chargeable to the furnace as compared to that lost due to delays for which the foundry alone was to blame.

Fig. 4 shows a working installation of a furnace of the type described, which has a melting capacity of 1500 lb. of brass per hour. The most recent design of this type of 1500-lb. furnace is shown in Fig. 5.

INDUCTION FURNACE VS. RESISTANCE FURNACE

The induction furnace is said to be exceptionally efficient thermally while melting. Its overall working efficiency for the week is not appreciably different from that of the resistance furnace; but it is desired to call attention to the fact that kw.-hr. per ton consumed in melting may by no means indicate the highest overall working efficiency.

Suppose, for illustration, we concede that the induction type of furnace has the highest thermal efficiency in melting. A certain furnace of this type has a crucible capacity of 400 lb. and a load loss or radiation of 8 kw.-hr. per hr. and melts a charge of red brass each hour. Suppose the charge is poured at 1300 deg. C.; it is necessary to use hand ladles preheated in pouring the charge. The furnace must be kept hot 24 hr. per day when the crucible has once been heated up. Let us now compare the effective working kw.-hr. consumption per ton with that of a 2250-lb.-per-hour tilting type resistance furnace of the design described and melting 18,000 lb. of red brass per 8-hr. day. It will be noted that this furnace may be charged by machine, whereas the crucible furnace must be carefully charged by hand. The pouring of the charge will be by hand with preheated ladle, and should cost the same as pouring a like quantity of metal from crucibles.

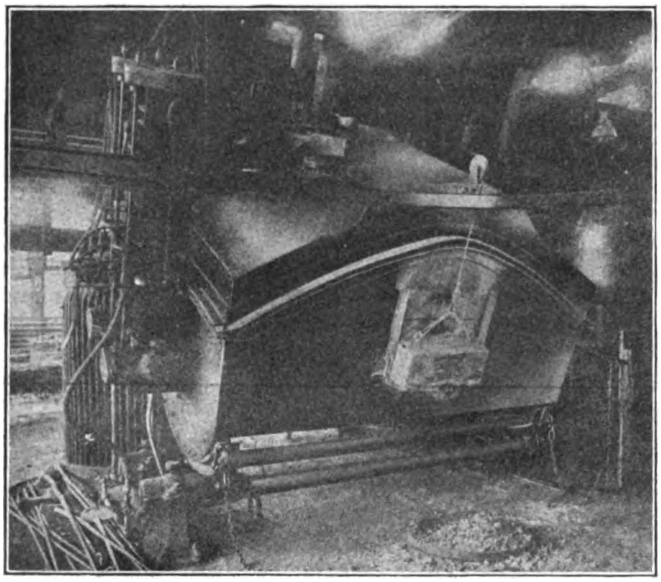


FIG. 4. 1500-LB. 300-KW. BRASS-MELTING FURNACE

It seems, since five to six 400-lb. crucible furnaces must be employed to give the same metal output as one 2250-lb. tilting furnace, that labor of attendance charging and melting per ton should cost at least 2¼ times as much in a crucible furnace as in a tilting hearth type Hence, it follows from the above:

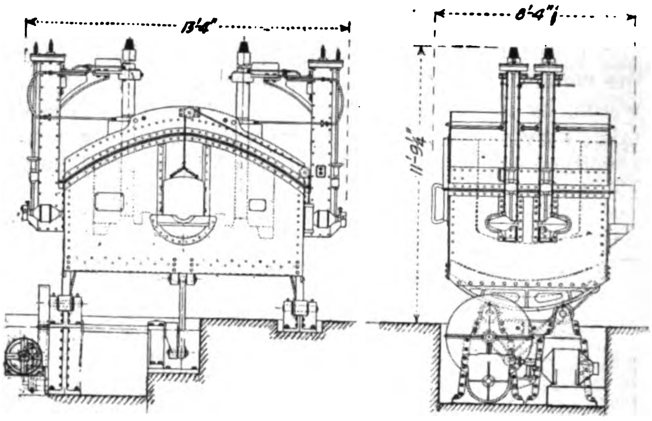


FIG. 5. CLASS I, TYPE C, BRASS-MELTING FURNACE, CONTACT ARC RESISTANCE TYPE

Metal melted per week in 400-lb. crucible induction furnace 8-hr. working day	48 × 400 = 19,200 lb.	
Kw.-hr. to melt 19,200 lb. at 200 kw.-hr. per ton	200 × 9.6 = 1,920 kw.-hr.	
Kw.-hr. to keep furnace hot while not melting (24 × 7 = 168), 168 — 48 = 120 hr. per week	120 × 8 = 960	
Total kw.-hr. per week	2,880	
Kw.-hr. per ton	2,880 + 9.6 = 300	
Power cost per ton at $0.01 kw.-hr		$3.00
Excess labor cost of 400-lb. crucible furnace over 2250-lb. tilting hearth per ton		1.25
Total		$4.25

This $4.25 is the power cost that may be allotted per ton to the 2250-lb. furnace and maintain an equal all-week efficiency for the same total amount of metal melted by either furnace. In other words, if the large tilting furnace melts with the not unexpected consumption of 425 kw.-hr. per ton, it has equaled the performance of the induction crucible furnace, which, offhand, seems much more efficient because we say it melts for 200 kw.-hr. per ton. Large-capacity induction furnaces might change the above somewhat, but the writer does not know of any successful design on the market at present for melting brass in capacity exceeding 600 lb. In fact, these are limited in their use to certain mixtures only. Leaded brass above 3 per cent cannot be successfully handled, due to the fluxing action on crucibles, etc.

The above clearly shows that a furnace should not be selected merely because it melts at a low kw.-hr. per ton, but all its other characteristics should be studied and its overall cost of turning out metal should be considered, when conforming to local conditions, since different working cycles may give widely different overall results.

COST OF ELECTRIC MELTING VS. FUEL-FIRED FURNACES

Attention is called to certain characteristics, losses, handicaps, etc., which influence the overall cost of melting and must be considered in making up true melting costs. These will now be considered and their effect shown upon costs as tabulated in Table I.

This table gives average data by which one may judge correctly as to the general problem of electric vs. fuel-fired furnaces. Results for individual foundries may be readily found by substituting in the itemized costs those which correspond to local conditions. Thus: 1.5c. per

TABLE I—AVERAGE COST OF MELTING BRASS WITH FUEL-FIRED OR ELECTRIC FURNACE

Furnace type	Pit	Pit	Tilting	Pit	Reverb.	Pit	Tilting	Crucible	Crucible	Tilting	
Furnace draught	Natural	Forced	Forced	Natural	Natural	Forced	Forced	Burner	Burner	Electric	
Furnace fuel	Coke	Coke	Coke	Coal	Coal	Oil	Oil	Natural gas	City gas	Electric	
Fuel cost price	$9.75	$9.75	$9.75	$8.00	$8.00	$0.098 gal.	$0.098 gal	$0.30M.	$0.60M.	$0.015 per kw.-hr.	
Cost per Ton, Making Red Brass, Pouring at 1300 Deg. C. Zn 10 Per Cent or Less											
Fuel quantity	1400	700	600	1200	900	50 gal.	60 gal.	4800	7000	400 kw.-hr.-10 hr.	250 kw.-hr.-24 hr.
Metal loss	70	30	30	70	124	30	44	40	40	15	
Fuel cost	$6.82	$3.41	$2.92	$4.80	$3.60	$4.90	$5.88	$1.44	$4.20	$6.00—	$3.75
Zinc value at 10c. lb	7.00	3.00	3.00	7.00	12.40	3.00	4.40	4.00	4.00	1.50	1.50
Cost reclaiming	.50	.50	.50	.50	.50	.50	.50	.50	.50	.15	.15
Renewals and repairs	.40	.40	.35	.40	.50	.50	.50	.35	.30	1.00	1.00
Cost preheating crucible	.40	.40	.40	.40	.40	.40	.10	.40	.40	.10	1.10
Furnace labor	2.25	2.25	2.25	2.25	1.50	2.25	1.50	2.25	2.25	1.00	1.00
Miscellaneous and labor and fuel	.50	.50	.50	.50	.50	.40	.40	.40	.40	.20	.20
Cost charcoal	.12	.12	.12	.12	.12	.12	.12	.12	.12	.05	.05
Air for blast	.....	.15	.15	.....	.....	.15	.15	.15	.15	.....	.....
Crucible cost	5.00	5.50	5.50	5.00	.....	8.00	.....	8.00	8.00	.....	.....
Interest—Crucible stock	.10	.10	.10	.10	.....	.10	.....	.10	.10	.....	.....
Lining pouring crucible	..	.....	.30	.....	.30	.....	.30	.30	.30	.30	.30
Electrodes and coke	.....	.....	.....	.....	.....	.....	.....	.....	.....	.60	.60
Cost per ton—Total	$23.09	$16.33	$16.09	$21.07	$19.82	$20.32	$13.85	$18.01	$20.72	$10.90	$8.65
Cost Per Ton; Making Yellow Brass. Zn 10 to 40 Per Cent											
Fuel quantity	1000	600	400	700	400	40 gal.	45 gal.	.....	.....	350 kw.-hr. 10-hr. day	220 kw.-hr., 24-hr. day,
Metal loss	100	40	56	100	200	60	70	.....	.....	30	
Fuel cost	$4.88	$2.92	$1.95	$2.80	$1.60	$3.92	$4.41	.....	.....	$5.25	$3.30
Zinc value at 10c. lb	10.00	4.00	5.60	10.00	20.00	6.00	7.00	.....	.....	3.00	3.00
Cost reclaiming	.50	.50	.50	.50	.50	.50	.50	.....	.....	.15	15
Renewal and repairs	.40	.40	.35	.40	.50	.50	.75	.....	.....	1.00	1.00
Cost preheating crucible	.40	.40	.40	.40	.40	.40	.10	.....	.....	.10	.10
Furnace labor	2.25	2.25	2.25	2.25	1.50	2.25	1.50	.....	.....	1.00	1.00
Miscellaneous and labor and fuel	.50	.50	.50	.50	.50	.40	.40	.....	.....	.20	.20
Cost charcoal	.12	.12	.12	.12	.12	.12	.12	.....	.....	.05	.05
Air for blast	.....	.15	.15	.....	.....	.15	.15	.....	.....	.....	.....
Crucible cost	4.50	5.00	5.00	4.50	.....	4.50	.....	.....	.....	.....	.....
Interest—Crucible stock	.10	.10	.10	.10	.....	.10	.....	.....	.....	.....	.....
Lining pouring crucible	.....	.....	.30	.....	.30	.....	.30	.....	.....	.30	.30
Electrodes and coke	.....	.....	.....	.....	.....	.....	.....	.....	.....	.60	.60
Cost per ton—Total	$23.65	$16.34	$17.22	$21.57	$25.42	$18.84	$15.23	.....	.....	$11.65	$9.70

kw.-hr. has been used as electricity or power cost; if this is 1c. in the plant under consideration, this figure should be substituted. Likewise other values may be converted to actual ones for an actual local condition.

TABLE II—SOURCES OF METAL LOSS IN MELTING

	Electric	Fuel Fired
Temp. control	Excellent	Indifferent
Size of charge	Controllable	Controllable
Gas flow from furnace	Negligible	Large volumes if combustion gases must pass out
Furnace atmosphere Chemical condition	Free from oxygen and injurious gases	Contaminated by impurities of fuel. Protection against oxygen only through excess fuel supply
Speed of melting	Much greater than fuel-fired	Much less than electric

It will be noted from Table II that conditions are under absolute control in the case of the electric, whereas in fuel-fired furnaces the control of temperature is indifferent, and large volumes of gases of combustion must pass through the furnace. Likewise, since heat is generated through the oxidation of fuels, the furnace chamber cannot be free from oxidizing and contaminating influences upon the metal.

FIRST SOURCE OF LOSS

Temperature Control. In a given electric furnace, the amount of metal lost in melting increases as the temperature for forming the alloy lies above the melting point of the alloy. Lack of temperature control may increase the metal losses in melting brass, as illustrated by the following tests: First, 70:30 brass is made in the electric furnace, taking 420 lb. of copper and melting down and then adding 180 lb. of zinc, at 1170 deg. C., pouring at 1150 deg. C. Second, 420 lb. of copper was melted down and 180 lb. of zinc added at 1100 deg. C. and pouring at 1100 deg. C., with results shown in Table III.

TABLE III.

	Yellow Brass Metals	Temperature of Alloying	Pouring Temperature	Alloy Recovered lb.	Per Cent Zn Loss	Per Cent Metal Loss
(a)	420 lb. Cu 180 lb. Zn	1170 deg. C. 2140 deg. F.	1150 deg. C. 1150 deg. C.	565	19	5.8
(b)	420 lb. Cu 180 lb. Zn	1100 deg. C. 2010 deg. F.	1100 deg. C.	590	5.6	1.6
The chemical tests corresponding to the above are:						
(a)	Cu 70 Zn 30	1170 deg. C.	1150 deg. C.	Cu 75.9 Zn 24.1	24	7.3
(b)	Cu 70 Zn 30	1100 deg. C.	1100 deg. C.	Cu 71.3 Zn 28.7	5.5	1.6

The results in Table III show the effect of temperature on the same metal (yellow brass) and how one may readily control the melting loss in the electric furnace by observing the alloying or pouring temperatures.

SECOND SOURCE OF LOSS

Size of Charge. Pounds metal lost on melting is independent of the charge in a given electric furnace, free from ventilation.

Metal Melted, Lb.	Charge Lb.	Charge Per Cent of Capacity	Temp. Melt Deg. C.	Metal Loss Per Cent
2696	674	70	1100	1.4
3727	932	100	1200	1.3

THIRD SOURCE OF LOSS

Gas Fow From France. In the fuel-fired furnace the magnitude of loss from this source is influenced by the speed of melting, and by the pressure, volume and velocity of the gases flowing over the melting metal. Thus increasing the atmospheric pressure in the furnace and decreasing the volume and velocity of the gases tend to reduce the volatilization loss. For each fuel there is a maximum limit to gas speed or velocity through the furnace, since each fuel in developing the required heat units to get the heat out at a given speed must develop a certain volume of gases which must pass out. Hence proper gas velocity is inseparably connected with products of combustion results from various fuels. Approximate volume of flue gases averages in coal, coke and oil furnaces from 3350 to 5800 cu.ft. per 100 lb. of metal melted. Hence it is easy to see how the flow of gas may bring about a very large volatile loss in the fuel-fired furnace. In the electric furnace the gas flow is very small, and consequently, though its atmosphere be saturated with metal vapors, so little gas leaves the furnace during the melt that the loss resulting is negligible.

TABLE IV. METAL RECOVERY TEST

(Actual Test on Red Brass)

Metal Charged	Metal Recovered	Per Cent Loss	Type Furnace
1 heat, 1500 lb.	1465 lb.	2.33	Electric tilting
1 heat, 1500 lb.	1484 lb.	1.07	Electric tilting
4 heats, 250 lb.	980 lb.	2.00	Coal-fired crucible
4 heats, 250 lb.	990 lb.	.85	Coal-fired crucible

The chemical analysis for melting loss on the same electric furnace, and the same metals, showed approximately 0.4 per cent Zn loss.

	Sn	Pb	Cu	Zn	Fe
Analysis of metal charged	4.30	6.55	80.88	8.02	0.25
Analysis of metal poured (no charcoal)	4.29	6.60	81.46	7.61	0.25

TABLE V. ACTUAL TEST (YELLOW BRASS) ELECTRIC FURNACE

	Metal Charged	Metal Poured	Per Cent Loss
	600 lb.	590 lb.	1.67
Metal recovery test	Charged Cu 70	Zn 30	
Analysis metal loss	Poured Cu 71.3	Sn 28.6	

TABLE VI. ELECTRIC FURNACE MELTING PHOSPHOR BRONZE

Metal Recovery Test (Actual):

Metal charged, 2696 lb. Metal poured at 1100 deg. C., 2656 lb. Loss, 1.4%

Metal charged, 3727 lb. Metal poured at 1200 deg. C., 3678 lb. Loss, 1.3%

Physical Test of Metal:

Open flame oil furnace and electric furnace melting same kind of brass.

	Electric Furnace	Oil Furnace
Tensile strength	27,900	24,969
Yield point	10,844	9,850
Elastic limit	7,300	7,000
Elongation in 2 in., per cent	19.4	16.9
Elongation in 8 in., per cent	17.2	14.9
Reduction of area, per cent	21.4	19.7

	Crucible Furnace	Electric Furnace
Tensile strength	30,250	30,820
Elastic limit	17,833	18,000
Elongation, per cent	16.14	19.37
Reduction of area, per cent	16.10	22.00

FOURTH SOURCE OF LOSS

Oxidation and Gas Absorption. Copper, zinc, tin and lead, the constituents of commercial brasses, are all very readily oxidizable at the temperatures to which they must be heated for melting and pouring. Oxidizing results in loss of metal and actually burns the metal to a dross. One can readily maintain a neutral or reducing atmosphere in the electric furnace, but it is certain that carbon monoxide must be so high and oxygen so low that one cannot, in ordinary furnaces, hope to maintain a reducing atmosphere without sacrificing many heat units through burning carbon to CO instead of CO_2.

Gas absorption is proportional to the temperature and the time the metal is held in contact with the gases. Incidental and intimately connected with oxidation of the metal is the absorption of gases. In melting the constituents of an alloy, a gas may enter into chemical union with some of its metals, forming oxides, or they may be occluded in the alloy. As an illustration: When silver is molten (1020 deg. C.), it can absorb about 20 times its own volume of oxygen. On cooling it gives up the oxygen absorbed, as evidenced by the well known spitting of silver on freezing. Absorption of gases is greater as the temperature increases. Since, when the metals freeze, absorbed or dissolved gases are given up, if these are unable to pass through the metal before it freezes it will produce sponginess and blow-holes in the alloy. The same effect may be produced by air trapped in pouring, by gases evolved by molds or cores when hot metal enters them; but dissolved gas is unquestionably a principal source of porosity and blow-holes. All fuels used in the foundry at the present time contain sulphur in some degree. This sulphur is a very common cause of trouble. Melted brass absorbs sulphur greedily and gives it up on cooling in the sand molds and forms porosity and blow-holes. One successful brass foundry asserts that many of the failures usually attributed to oxygen are really due to sulphur. In the most careful crucible melting in coke-fired furnaces, the metal will absorb 0.002 to 0.005 per cent sulphur. Sulphur accumulates in a metal each time it is melted, which accounts for dark skin on re-run castings as compared with first melt metal. In fact, even though melted under a charcoal cover and CO blanket, copper needs a deoxidizer to free it completely from oxygen. These troubles should not occur in connection with electric melting, since the furnace chamber may be kept uncontaminated and free from oxygen and injurious gases.

TABLE VII. NON-FERROUS METALS MELTED IN ELECTRIC FURNACE

Metal	Condition of Metal Charged	State of Metal After Melting	Kw.-Hr. per Ton to Melt	Metal Loss in Melting
Copper	Electrolytic cathode Pig Scrap, heavy Scrap, light Scrap, dirty Chips, oily Chips, clean	Pig at pitch without rabbling or poling Wire bar Foundry castings	300 to 500	No oxidation; a certain amount of copper oxide is reduced
Zinc	Electrolytic cathode Pig Punchings Chips Heavy scrap	Pig Foundry castings Billets for rolling Battery electrodes	90 to 120	Dross and oxidation under 2 per cent
Nickel	Shot Bar Scrap	Pig Foundry castings Billets for rolling	500 to 750	No oxidation loss
Aluminum	Pig Scrap Punchings Turnings	Pig Foundry castings Billets for rolling	400 to 750	Less than 1 per cent oxidation
Tin	Bar Pig Scrap	Bar Pig Wire	40 to 60	No oxidation
Lead	Pig Scrap Sheet	Billets for rolling Casting Pig	20 to 40	No oxidation

FIFTH SOURCE OF MELTING LOSS

Speed of Melting. The loss of zinc is proportional to the temperature and length of time the metal is held at the high temperature. This statement means that if you melt one charge at the rate of 100 lb. per hr., and a second charge at the rate of 200 lb. per hr., all other conditions being the same, the melting loss of the second charge will be less than that of the first charge. Electric methods of melting lend themselves to much quicker melting or higher melting rates than with fuel-fired furnaces.

DETERMINATION AND MEASUREMENT OF METAL LOSS

Metal loss in melting is ordinarily best judged from chemical analysis of the metals charged. This test eleminates errors arising from furnace walls, absorption or the reverse, and also the losses in pouring.

To show the inconsistency of the actual recovery method of loss test, results of comparative tests on coal-fired crucible furnaces and electric furnaces are given in Table IV. Crucible capacity 250 lb. Electric furnace capacity 1500 lb. The metal was poured from the crucible directly, whereas an auxiliary ladle was used to pour the 1500 lb. from the electric furnace, thus giving chances for greater loss in pouring.

Tables VII, VIII and IX show the average performance to be expected from the use of the electric furnace, with the furnace charge in different physical form, etc. Table X shows like results for fuel-fired furncaes.

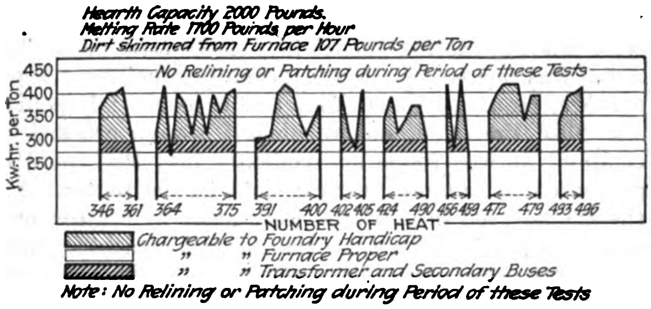


FIG. 6. POWER REQUIRED FOR MAKING RED BRASS FROM DIRTY SCRAP IN ELECTRIC FURNACE

TABLE VIII. NON-FERROUS ALLOYS MADE IN ELECTRIC FURNACE

Metals	Condition of Metal Charge	State of Alloy After Melting	Kw.-Hr. per Ton	Metal Loss, Per Cent
Red Brass				
Cu 80 Zn 10 Sn 6 Pb 4	Scrap pig, electro. cathodes Scrap bar Scrap pig	Foundry castings Wire bar Billets	250 to 400	0.25 to 0.75, depending upon manipulation of furnace
Yellow Brass				
Cu 60 Zn 39.5 Pb 00.5	Scrap, pig, electro. cathodes Scrap, pig	Foundry castings Wire bar Billets for rolling	220 to 350	0.50 to 1.5

TABLE IX

Alloy	Condition of Alloy Charged	State of Alloy After Melting	Kw.-Hr. per Ton	Alloys Loss per Cent	Temp. Deg. C.
Red Brass	Yellow brass and copper or red brass and zinc, pig scrap and sprues, turnings and chips	Foundry castings Wire bar Billets	225 to 300	0.15 to 0.50	1300
Yellow Brass	Red brass and zinc or yellow brass and zinc, pig scrap sprues, turnings and chips	Foundry castings Wire bar, Billets	200 to 275	0.40 to 1.00	1100
Monel	Copper nickel Scrap and billets	Foundry castings, Billets	500 to 750	No oxdation	1600
Aterite	Cu sprues, scrap Ni virgin metal Zn	Foundry castings, Billets for drawing and rolling	500 to 750	2%Zn. loss out of 32 per cent	1650

TABLE X. AVERAGE MELTING RESULTS, REALIZED IN THE AVERAGE FOUNDRY WITH FUEL-FIRED FURNACES

Type	Furnace Draught	Fuel, Kind	Per Ton	Metal Loss	Red Brass, Low Zn, 10 per Cent and Less Yellow Brass, High Zn, More Than 10 per Cent
Pit	Nat.	Coke	1400 lb.	3.5	Red brass
			1000 lb.	5	Yellow brass
Pit	Forced	Coke	700 lb.	1.5	Red brass
			600 lb.	2	Yellow brass
Tilting	Forced	Coke	600 lb.	1.5	Red brass
			400 lb.	2.8	Yellow brass
Pit	Nat.	Coal	1200 lb.	3.5	Red brass
			700 lb.	5	Yellow brass
Reverb.	Nat.	Coal	900 lb.	6.2	Red brass
			400 lb.	1	Yellow brass
Pit	Burners	Oil	50 gal.	1.5	Red brass
	Tangential		40 gal.	3	Yellow brass
Tilting	Open flame	Oil	60 gal.	2.2	Red brass
	Atomizing Burners		45 gal.	3.5	Yellow brass
Tilting Crucible	Burners Tangential	Nat. gas	4800 cu.ft.	2.75	Yellow brass
Tilting Crucible	Burners Tangential	City gas	7000 cu.ft.	2.75	Yellow brass

The results given in the tables are average figures and will be influenced to meet any particular foundry by

(a) Promptness of pouring.
(b) Temperature.
(c) Local conditions, such as physical condition of metal charged, its cleanliness, volume of air and products of combustion which pass through the furnace in natural draught furnaces.

This varies from day to day, depending on the weather.

(d) Design of furnace.
(e) Manipulation of furnace.
(f) Size of crucible.
(g) Percentages of composition.
(h) Length of working day.
(i) Whether observations are based on hot furnace and hot crucibles or whether the first heat of the day is excluded.
(j) Whether pouring light or heavy castings. Pouring light castings requires hot metal, and pouring heavy ones requires metal at lower temperature.
(k) Whether results are from careful tests or whether they represent actual foundry or rolling mill practice and extend over a considerable period.

Curve sheet (Fig. 6) illustrates how the furnace which is able to turn out metals for 300 kw-hr. per ton requires in reality an average of 350 kw.-hr. per ton due to foundry handicap.

CONCLUSION

In conclusion, the chart, Fig. 7, shows the excess cost for melting brass, and is made up from curves and tables preceding it. It is assumed that all the brass in the country is melted, (1) in fuel-fired furnaces, all types being employed equally; (2) that the same work is done in the electric furnace. The cases of red brass and yellow brass have been considered. Four conditions are shown, viz.: 10-hr. day—(1) melting yellow brass, (2) melting red brass; 24-hr. day—(3) melting yellow brass, (4) melting red brass.

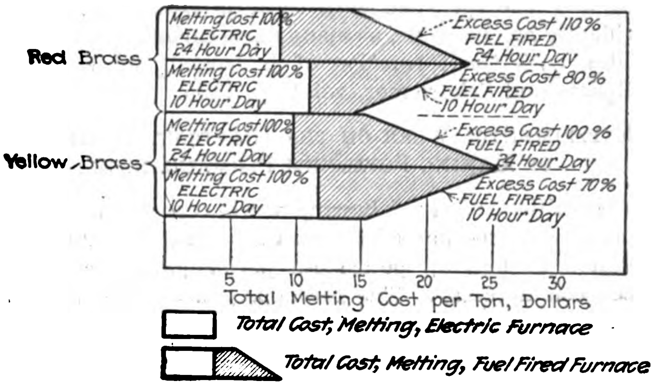


FIG. 7. CHART SHOWING EXCESS COST MELTING BRASS

The shaded portion of each wedge shows the saving in total cost between melting with fuel and with electricity. This chart stated in words and figures is as follows:

Furnace	Alloy Melting	Length Working Day, Hr.	Per Cent Saving Over Fuel-Fired
Electric	Yellow brass	10	100
Electric	Red brass	10	80
Electric	Yellow brass	24	110
Electric	Red brass	24	70

These margins of savings are of such magnitude that we cannot longer doubt that the electric furnace is destined to dominate completely the brass-melting field.

Potassium Permanganate From Ferromanganese by Electrolysis

BY M. DEKAY THOMPSON

THE fact that permanganate is produced by the electrolysis of manganese or ferromanganese anodes in alkaline solutions was first recorded by R. Lorenz (*Z. f. anorg. Chem.*, vol. 12, p. 393, 1896) in a brief notice which gave no further information than the statement above. The anodic behavior of manganese in solutions of sodium sulphate alone and with additions of sodium hydrate, and in solutions of acid sodium phosphate (NaH_2PO_4), with and without additions of sodium hydrate, is the subject of part of an article by W. J. Müller (*Z. f. Elektrochem.*, vol. 11, p. 755, 1905). His principal result is that hydroxyl ions produced passivity, as shown by potential measurements.

A study of ferromanganese anodes in caustic soda solutions was made by G. R. White (*J. Phys. Chem.*, vol. 10, pp. 502-513, 1906). This paper, however, is largely taken up with a discussion of the reduction of permanganate to manganate in alkaline solutions, and scarcely any electrochemical data are given. The anode current densities were 2.5 to 12.5 amp. per sq.dm., the temperatures from 20 deg. C. to 95 deg. C., the concentrations 2 to 10 per cent. The maximum current efficiency was 12 per cent (under what conditions is not stated).

C. J. A. Griner patented the process of making permanganate by the electrolysis of manganese carbide anodes in concentrated sodium hydrate (German patent 125,060, July, 1900). It is claimed that manganese carbide anodes are superior to ferromanganese, as it is stated ferromanganese anodes have to be cleaned frequently on account of the formation of manganese dioxide, and also the yield with these is low. This patent evidently has no value, as manganese carbide decomposes water with the formation of hydrogen and methane. (Roscoe and Schorlemer, vol. 2, p. 1155.)

EXPERIMENTAL WORK ON THE ELECTROLYTIC METHOD OF MAKING POTASSIUM PERMANGANATE

The object of the following work (carried on in the spring and summer of 1918) was to see whether this method of making potassium permanganate could be used commercially. The ferromanganese used had the following composition:

	Per Cent.		Per Cent
Manganese	75.1	Silicon	0.9
Iron	16.7	Phosphorus	0.2
Carbon	6.1		
		Total	99.0

It also contained copper, nickel, calcium, magnesium, and arsenic.

Small-scale experiments with a solution of potassium hydrate containing 24 g. per 100 cc., with an anode current density of 20 amp. per sq.dm. (180 amp. per sq.ft.) at 45 to 50 deg. C. showed that the electrolysis proceeded for a few hours with a current efficiency of 15 per cent, but that there was a coating of oxides formed on the anode, which gradually protected the metal beneath from the further action of the current. An attempt to overcome this by using a pulsating current was not successful.

On replacing the hydrate solution by a 20 per cent carbonate solution no further trouble was encountered by the scale protecting the metal, other conditions remaining the same.

On a subsequent occasion, when the hydrate solution was used again, the anode was not attacked, but gas was evolved instead. This would appear to be a case of passivity, which was doubtless due in part to the hydroxyl ions. Why it appeared in this case and not in the first experiments is not clear.

EXPERIMENTS IN LARGE CELL

The next step in the evolution of this process was to try it on a semi-commercial scale. A cast iron plater's tank of the following inside dimensions was used: at top, 53 x 33 cm., at bottom 47 x 26 cm., and 38 cm. deep. A wooden pattern 2 cm. thick, of the shape of an anode used in copper refining, was made, and several attempts were made at casting anodes in a closed sand mold. The metal was melted in a Dixon graphite crucible in a pot furnace, requiring about four or five hours. It poured and filled the mold, but the metal always cracked on cooling. It was found subsequently that this could be prevented by cutting vertical slots in the pattern, but the anodes used in this tank were made by casting bars of the metal in open sand molds, and attaching these to an iron crosspiece. They were not annealed. A hole was left in one end for a bolt. The dimensions were 2.5 x 5 x 36 cm. The cathodes were sheet iron, the diaphragms asbestos cloth bags, the edges held together by bent iron strips. On account of the expense, the quality of the asbestos was not as good as that used in the small-scale experiments, and holes could be seen in it on holding it up to the light. An attempt was made later to improve the diaphragms by painting them with some of the anode mud. There were five anodes and six cathodes. The experiments were not successful, because the cell heated up to 70 deg. C. from the passage of the current and this caused a layer of oxides to form on the anode, which prevented electrolytic attack, as in the case with hydrate solutions. The electrolytic tank was then placed in a tub through which tap water circulated. This kept the temperature down to 40 deg. C. and there was no further difficulty and the anodes never needed cleaning. The current used was limited by the temperature of the tap water, which allowed only a limited amount of cooling. In the following runs the full number of anodes was not always used because of breakage. The current density was approximately 7 amp. per sq.dm. (65 amp. per sq.ft.) at about 4.2 volts, and the total current about 350 amp. The concentration of potassium carbonate was maintained at about 200 g. per liter. The volume of electrolyte was about 35 liters. The electrolysis lasted only from 9 a.m. to 9 p.m. and the cell stood idle over night. After electrolyzing four or five days, the liquid and anode mud were removed and heated to about 90 deg. C. to cause all permanganate crystals to dissolve. The liquid was then filtered through a large asbestos filter under suction, and the filtrate was allowed to crystallize. The anode mud was removed from the filter, was washed several times with hot water and the wash water added to the main solution, but it would have required many washings to get the mud free from permanganate and carbonate. Even after four washings crystals of permanganate would appear on the surface of the mud on drying. This suggested the idea that it would be more efficient to allow the mud to dry before the final washings, and while no accurate data were obtained to confirm this point, this procedure did seem to give better results.

On cooling, the mother liquor was drained off and the crystals centrifuged with a little washing by sprinkling. They analyzed over 98 per cent pure. Approximately 40 lb. was made during these experiments.

RESULTS WITH LARGE CELL

No.	Amp.	Amp. Hr.	Kg. $KMnO_4$ Produced	Per Cent Current Eff.	Kw.-Hr. Per Kg.	Per Cent Mn Converted to $KMnO_4$	Loss in Weight of Anodes, Kg.
2	350	17,370	1.68	11.0	44	....	....
3	350	16,000	2.00	17.6	32	....	....
4	350	21,200	3.84	21.6	25	....	....
5	350	18,880	2.79	18.6	30	34.5	3.78
6	350 to 400	19,820	2.15	13.2	40	62.5	2.1
7	350	21,330	3.42	19.2	28	62.5	2.52
Average				17.0	33		

The total anode mud made weighed 21.5 kg., the permanganate 20.7 kg. A considerable portion of this mud was found in the cathode compartments, showing that permanganate diffused through the diaphragm and was reduced. This would occur to a less extent with better diaphragms, and would increase the current efficiency.

It was found that the anodes were attacked very much more near the surface of the electrolyte than at the lower end, evidently on account of relatively poor electrical conductivity of this alloy. It would therefore seem advisable to cast the anodes with a taper toward the lower end.

These experiments sufficed to determine only the cost of materials and power for the manufacture of potassium permanganate. These are the following, assuming the ferromanganese to cost $260 per 2240 lb., power $20 per hp.-yr., and 85 per cent potassium carbonate 40c. a lb.:

Required for 1 lb. of potassium permanganate:

1 lb. ferromanganese	$0.12
15 kw.-hr.	.05
0.52 lb. 85 per cent K_2CO_3	.21
Total	$0.38
For 1 kg. the cost would be	$0.84

Other expenses of this manufacture which would have to be determined by a small experimental plant are: Cost of casting anodes, cost of installation, labor, etc. The anode mud, consisting of oxides of iron and manganese, could doubtless be sold for something.

Since writing the above an article on sodium permanganate by Wilson and Horsch[1] has appeared.

The results of their work differed from those above in that the higher current efficiency of 35 per cent was obtained, and 7 volts per cell were used. Perhaps the most important difference is that the anodes had to be cleaned by sand-blasting every 24 hr. In order to see whether this was due to using sodium carbonate in place of potassium carbonate, the original anode used by me was tested in sodium carbonate, without cleaning since last used in potassium carbonate.

The results were the following:

G. Na_2CO_3 per 100 cc	15.7	Amp. per sq. dm	5.2
Duration, hr	85	Amp. hr	254
Temp. deg	40	Per cent current eff	20.5
Volts	4.2	Per cent Mn converted to MnO_4	66

The run was continuous for 3, 26, 27 and 30 hr., but the anode was not cleaned at any time. This shows the lack of necessity for cleaning the anode is a property of the anode, as it behaves the same in sodium carbonate as in potassium carbonate, at this temperature.

Some ferromanganese used by Wilson and Horsch, which required periodic cleaning when used as anode was analyzed, with the following result:

Manganese	78.5	Silicon	1.2
Iron	13.8	Phosphorus	0.2
Carbon	6.8		
		Total	100.5

The principal difference between this alloy and that used in the above work is that this contained about 3.5 per cent more manganese and a corresponding less amount of iron. This would hardly seem to be sufficient to account for the different anodic behavior, but in order to test this point an anode was made by melting some of the 78.5 per cent ferromanganese with the calculated amount of steel turnings to make 75 per cent ferromanganese. This anode was not analyzed, so the composition may not have been exactly that desired. This anode electrolyzed for a longer time without requiring cleaning, but eventually the voltage did rise and the scale had to be removed before the electrolysis could be continued. This merely indicates that the anodic behavior of ferromanganese is quite sensitive to its composition.

The author hopes to resume this investigation later, but as the work has to be discontinued for the present, it is not considered advisable to delay further the publication of the results obtained.

SUMMARY

These experiments show it is possible to manufacture potassium permanganate from commercial ferromanganese, containing about 75 per cent manganese, by electrolysis in a potassium carbonate solution without the necessity of ever cleaning the anodes. The temperature must not be allowed to rise much above 40 deg. C., for if it does an insulating coating of oxides is formed, which prevents the production of permanganate. Carbonic acid is not lost in the electrolysis. The current efficiency was about 17 per cent, but it would be higher with better diaphragms. The current density was 65 amp. per sq.ft. The anodes are attacked more at the top than at the bottom.

The anodic behavior, as regards formation of insulating scale, is affected by a small change in the relative amounts of iron and manganese in the anode.

Massachusetts Institute of Technology,
Cambridge, Mass.

Short Course in Ceramic Engineering

The Department of Ceramic Engineering of the University of Illinois is engaged in making preparations to give a two-weeks short course in ceramic engineering in February, 1920. This short course will follow in general the same lines as the short course given in 1918, and will include lectures and laboratory work in the physics and chemistry of ceramic materials and processes; mining, sampling, handling and testing of clays; shaping, drying and burning; machinery and equipment for the ceramic plant; refractories, glass, glazes, etc. The complete program of the course will be sent free to all who apply for it. The course is open to any person interested.

Explosive Plant at Nitro Sold

After some negotiation with bidders the Government has sold its explosive plant at Nitro, W. Va., to the Charleston Industrial Corporation of Charleston, W. Va. The figure agreed upon was $8,551,000.

---

[1] *Trans.*, Am. Electroch. Soc., April, 1919.

Industrial Magazines and Labor Conditions*

By Harry E. Cleland

IN JULY and August of this year there was an average of 336 strikes going on daily in the United States.

In the general fog there are at least two things clear: First, that there has been a pronounced and progressive decline in production. Second, that shorter hours and higher wages have not been compensated for by increased efficiency.

That portion of capital and management which regards labor as a commodity to be bought and sold, hired and fired must come out of its comotose condition. And that portion of labor which looks upon capital as an arch enemy and which is ruled by its radicals must throw the hobgoblin to the scrap heap and consign the swashbucklers to the same place.

Capital cannot afford to be reactionary. Labor cannot afford to be revolutionary.

There must be a real partnership before there can be a true industrial democracy. Fundamentally, real partnerships are based upon mutual confidence. Labor unrest is the result of a lack of such confidence.

Labor thinks that its cravings will be satisfied with more money. That is not true. Capital thinks that all that labor wants is more money and certainly labor does everything to give capital that idea. That, too, is untrue.

Labor wants a decent living wage based on what it produces plus as much interest in the things it produces as is possessed by the other hired men in the front office.

Business papers are the organs of industrial management in this country.

Labor Question Within Scope of Business Papers

It has been recognized for years past by the ablest business papers that the labor question as such comes within their sphere of activities. You will find that business papers as a rule have had and will have some constructive things to say on capital, management and labor, with the added advantage that they are not of necessity confined to the glittering generalities of the question but are able, because of their highly specialized character, to focus their comments upon the particular labor problems of the single industry they represent.

In the new light of things they will recognize fundamentally that capital and management are very seldom one and the same thing. Management is usually a hired man exactly as is any other worker in the plant.

And business papers will write it down as a basic principle that management must manage not only for the interests of capital but for the interests of labor as well. Otherwise its job is poorly done for both parties to the transaction.

Business papers, I believe, must point out clearly to their readers that a new industrialism is at hand. They must show that capital, management and labor are infested with certain fallacies and that these must be removed before any basis of mutual understanding can be reached.

It is a fallacy on the part of labor to say that production must be curtailed and that labor-saving machinery must be fought in order to make more work for more people.

It is a fallacy for labor to believe that it is the sole creator of wealth. The products of industry are only partly the work of labor.

It is a fallacy for labor to believe that the objects sought by capital are opposed to the objects sought by labor.

It is a fallacy for management to assume that it is accountable only to capital.

It is a fallacy for management to regard labor as a commodity to be bought and sold according to the law of supply and demand.

It is a fallacy for capital to contend that it is the sole factor because it supplies the funds.

It is a fallacy for capital to assume that it has no responsibility beyond supplying the funds.

It is a fallacy for capital to contend that all profits belong to it.

Papers Should Expose All Profiteering

I believe that business papers must expose to the light of publicity every flagrant case of profiteering it finds whether it be on the part of capital or labor. The man who pays $18 a ton for pig iron and sells it for $55 is a profiteer. The worker, who, having received advances amounting to nearly 75 per cent in two years, now demands—as New York printers are demanding—an immediate further increase of 65 per cent, is a profiteer plus. Certain elements of labor are howling to high heaven about the pitiless profiteers, but when it comes to sheer and unadulterated arrogance in profiteering, I commend you to the average insurgent union which, having broken loose from the wiser counsel of its international leaders, runs its rampant ruining race.

Business papers must report the progress, success or failure of all attempts on the part of capital, management and labor to form industrial democracies within the individual plants. They must show plainly why such attempts succeed or fail. Already there is a wealth of material. The pioneering of such concerns as the Colorado Fuel & Iron Co., the Midvale Steel & Ordnance Co., the International Harvester Co., Hydraulic Pressed Steel Co., the Multigraph Co. and many others is a matter of vital importance to every man, woman and child in the country.

Business papers should advocate that capital choose its managers on a basis first, of their ability to handle men, second, of their technical skill. The reverse has been the rule. And the reasons for this are so apparent that why any other course should have been chosen will remain a mystery always.

Why is it that one concern pays its men an average of $38 a week and gets unswerving loyalty and full production while another in the same locality pays an average of $41 a week, has labor trouble continuously and never reaches full production? It is because the manager of the first concern treats the workers like human beings, makes a point of knowing them personally, takes them into his confidence, and makes their shop life something more than a daily grind, while the other tries to cultivate loyalty with a slide rule and a micrometer.

Loyalty—and loyalty means production—is only incidentally a matter of money and hours; loyalty is a matter of mind and heart, and you can't produce it by any strong-arm methods—to get, the concern must give.

---

*Abstracts from a paper read before the Associated Advertising Clubs of the World, New Orleans, September, 1919.

THE OPEN SHOP ADVOCATED

It is also my belief that business papers should advocate the open shop.

The closed shop is un-American, and nothing un-American should be tolerated for a minute. Every American is born with or inherits the right to say where he shall work. Every American employer has the right to say whom he shall hire.

The closed shop tends to put all workers on the same dead level of mediocrity, throttles individuality, stifles initiative, curtails production and destroys the dignity and power of labor.

The opportunity for individual initiative, the possibility for any workman to become a master, has made this country what it is in manufacturing and all other industries.

The closed shop means the changing of all this to the foreign standard, where a workman is always a workman, where ambition is still-born and hope is dead.

The open shop means the freedom of every man to do what he thinks best for himself, provided he does not encroach upon the liberty of others.

This imported closed shop, that prevents young men from learning the trade; that restricts output; that keeps improved machinery products down; that forbids the owner of the plant from having his own foreman or any other representative in the workroom, is in itself wrong. It is against the liberty of men. It is slavery. It cannot be tolerated in a free country.

CAUSES OF LABOR TROUBLE

I said awhile ago that business papers ought to look into the causes of labor trouble and seek a remedy.

One of the principal causes of labor trouble is the reduction in piece rates.

If the worker on piece rates does exceptionally well and makes big money he is afraid, and usually justifiably, that his rate will be cut. In those circumstances, he produces just enough to make what seems to him will correspond to his possible maximum wage.

For instance: A boy in a New England factory was tapping nuts at a piece rate of 10 cents a hundred. His average production was 3000 nuts per day. One day he overheard the superintendent tell his foreman that the concern had decided to quit making that particular kind and size of nut. In that one day the kid tapped 8200 nuts!

No matter whether the employer pays by bonus, differential piece system, premium or what not, he must play fair if he expects full production. Business papers must advocate the square deal.

Now let us find out as nearly as we can what the sentiment of business in this country is on the labor question.

SENTIMENT OF THE COUNTRY AS POLLED

The United States Chamber of Commerce submitted 13 principles of industrial relations to the vote of its member organizations representing business associations of all kinds. Capital and management did this voting, mind you, not labor.

Four hundred and thirty-three organizations filed ballots in 44 States, the District of Columbia, Alaska and Hawaii. The vote was overwhelmingly in favor of 12 of the principles, and the Chamber of Commerce is now committed to the following:

1. Industrial enterprise, as a source of livelihood for both employer and employee, should be so conducted that due consideration is given to the situation of all persons dependent upon it.

2. The public interest requires adjustment of industrial relations by peaceful methods.

3. Regularity and continuity of employment should be sought to the fullest extent possible and constitute a responsibility resting alike upon employers, wage earners and the public.

4. The right of workers to organize is as clearly recognized as that of any other element or part of the community.

5. Industrial harmony and prosperity will be most effectually promoted by adequate representation of the parties in interest. Existing forms of representation should be carefully studied and availed of in so far as they may be found to have merit and are adaptable to the peculiar conditions in the various industries.

6. Whenever agreements are made with respect to industrial relations they should be faithfully observed.

7. Such agreements should contain provision for prompt and final interpretation in the event of controversy regarding meaning or application.

8. Wages should be adjusted with due regard to the purchasing power of the wage and to the right of every man to an opportunity to earn a living at fair wages, to reasonable hours of work and working conditions, to a decent home, and to the enjoyment of proper social conditions.

9. Fixing of a basic day as a device for increasing compensation is a subterfuge that should be condemned.

10. Efficient production in conjunction with adequate wages is essential to successful industry. Arbitrary restriction on output below reasonable standards is harmful to the interests of wage earners, employers and the public, and should not be permitted. Industry, efficiency and initiative, wherever found, should be encouraged and adequately rewarded, while indolence and indifference should be condemned.

11. Consideration of reduction in wages should not be reached until possibility of reduction of costs in all other directions has been exhausted.

12. Administration of employment and management of labor should be recognized as a distinct and important function of management and accorded its proper responsibility in administrative organization.

13. A majority was in favor of the thirteenth, which had to do with national employment offices, but it did not receive the required two-thirds vote.

Doesn't the action of the Chamber of Commerce look as if the spirit of fair play were abroad in the land?

There will always be differences of opinion, but they need not lead to riot and rape, bloodshed and murder, closed factories and open almshouses.

Fair play and co-operation fully exercised between capital and labor is after all a sovereign remedy for the ills of both. Co-operation saved the world. It can save this situation.

America's Case in Chemistry*

By Ellwood Hendrick

TOWARD the end of the eighteenth century, and in the beginning of the nineteenth, there were in this country distinguished and active contributors to research in chemistry. We have but to read the charming biographies of that delightful savant Dr. Edgar S. Smith, provost of the University of Pennsylvania, to appreciate not only the scholarship attained by such men as James Woodhouse, Robert Hare, Benjamin Silliman and others, but also their very considerable gifts to the common store of knowledge and understanding. It will be recalled that in those days Joseph Priestley, having discovered oxygen in England, came to America, not only to enjoy freedom of worship, but, being Unitarian in religious disposition, in order to avoid in a literal sense the brickbats of orthodoxy. To the end of his days Priestley held to the theory of phlogiston. It was an idea fixed in his mind that every dancing flame was a manifestation of the escape of this imaginary body, except when the ash weighed more than the burned substance. Then phlogiston was assumed to reverse itself and go backward. Woodhouse was modern in his views of combustion, championing those we hold today, following Lavoisier in France, and Klaproth in Germany. He had a doughty opponent, and, since Priestley spoke with great authority, the battle waged long and fierce, till the Englishman cried quits, although he remained unconvinced to the end of his days. I know of no more illuminating sidelight to throw upon the quality of the men at that time engaged in science in the United States than to point out that whenever Priestley was attacked on any other ground than that of the scientific heresy of phlogiston, Woodhouse would rush to his aid, supporting him in all his dignity as a great philosopher in science. Then, for a long time, chemistry seemed almost forgotten.

Franklin's Aid to Science

As a reason for this I venture to propose that in our earliest days as a nation we had a world figure in Benjamin Franklin, who was intensely interested in science, to aid us. It was he who advertised research in physical science in America. Now business men know the value of advertising. If they sell goods in packages with a trade mark, and can get this trade name sufficiently talked about, they can dispose of their product in vast quantities, and at a higher figure than the market price for the same goods. Other merchants may hold vast stocks of the identical wares and be unable to find a market for them. In later years scientific achievement in this country was sporadic, the contributions came from men born to their work, while recognition was infrequent and difficult to obtain. Joseph Henry would have been the master of physics that he was under any circumstances, but even today we do not accord him the full honor to which he is entitled. Simon Newcomb would have been a great astronomer whether he went to Washington or not, and Willard Gibbs worked in utter loneliness because his own colleagues did not appreciate or even understand him. Unlike the model child who may be seen but not heard, the man of science may be neither seen nor heard while engaged at his task. And afterward his findings are likely to be recorded in language almost cryptic, so that whatever rewards attach themselves to his name seldom reach him during his lifetime. Or if they do, they lack the trumpet-and-drum quality that appeal to us in youth while we are determining what career we shall pursue.

Had Abraham Lincoln or Theodore Roosevelt been a chemist the profession of chemistry would have had a far higher standing in this country than it has enjoyed. It would not have got out of focus. Even in public pronouncements these men, whose every word had news value, would have employed the illuminating chemical similes which are now slowly finding their way into the public consciousness.

The profession, I repeat, was out of focus. We did not have chemists enough because the subject was not talked about enough. Now, the special bent of brilliant minds is not always disclosed in youth. They have to feel their way along until they strike their *metier*, and it goes without saying that many a brilliant mind would have addressed itself to chemistry had the subject enjoyed the general consideration which is warranted by its importance. Chemistry was, in fact, a learned profession long before the tradition lost weight that law and divinity were the only suitable callings for a thoughtful man.

War Revealed Importance of Chemistry

When the great war came upon us the eyes of the people were opened. Chemists were suddenly needed, needed as never before—and how ours responded the world knows. We should not let the occasion pass without mentioning the ringing appeal of Dr. Julius Stieglitz of Chicago, then president of the American Chemical Society. Dr. Stieglitz knew neither rest nor sleep until he had sounded the country's resources in chemists and, with Dr. Parsons and the Bureau of Mines, had completed the rapid census of available men. We must note the competent organizing ability of Dr. W. H. Nichols that was called into play, and the forward march to Washington of chemical manufacturers who placed all their possessions at the service of the Government. Nor must we forget the organization of the Naval Advisory Board, and the earnest, constant and weighty contributions of such men as Willis R. Whitney and Leo H. Baekeland, the American University and its passionate tension of work in research, the seven-league boots in which W. H. Walker strode to production at the Edgewood Arsenal, the great work of by far too many of our leaders in chemistry even to name them in passing, and the thousands of glorious young men who rushed in from universities and laboratories, the country over, and threw themselves into the mighty effort. It was great, it was magnificent, and it showed the spirit of America as surely as this was shown by our soldiers on the battlefield. Neither did the Chemical Warfare Service fail. Working together with the British and the French under General Fries, it was ever on hand, the laboratories co-ordinating with the front, stubborn in defense, valiant in attack, until victory was won. It is a glorious record.

But here again we need the Voice of Authority in council. We lack our Benjamin Franklin to whom public opinion and men in office will give heed. We have no one who speaks with the Voice of Authority in science to the types of mind represented, for instance, in the Congress of the United States. We have the men, and these men can speak, but Congress will not listen. Neither will others who also should give heed.

---

*Paper read at the Fifth National Exposition of Chemical Industries, Chicago, Sept. 22, 1919.

The fact is brought home to us by the passing of the Chemical Warfare Service. This organization provides a means of overcoming an unprepared enemy without loss of life even, since, by proper use of lachrymator or other gases, enemy soldiers may be put *hors de combat* and taken prisoner *en bloc*, and yet they recover in a few hours, fully restored to health. We have learned that, given on the one side chemical preparedness, and unpreparedness on the other, the army thus scientifically equipped is almost certain to win, while the unprepared opponent is equally likely to lose. After the Germans launched their first chlorine attack against an unprepared enemy the Channel ports were wide open to them, and why they did not take them is still unexplained. This first attack with gas was an ethical breach, the responsibility for which will always rest with the Germans, but when the convention had been broken and gas came into use, it straightway became a recognized instrument of warfare, employed by all.

USE OF GUNPOWDER ONCE CONSIDERED UNSPORTSMANLIKE

It was started, just as once upon a time the use of gunpowder was started. The early introduction of shooting an enemy beyond the range of the bow and arrow was condemned as unsportsmanlike, and it *was* unsportsmanlike. It is far more valiant and manly in every way to meet an enemy face to face, sword in hand, in battle array, and fight it out with him in the open, than to murder him unawares. But the advantage rested with gunpowder, and accordingly gunpowder remains in use. We have also learned that if both sides are prepared and equipped, then chemical warfare is the most humane method of fighting yet devised, and that, while it kills, it leaves hardly any soldiers maimed or seriously incapacitated. As for the argument that chemical attack may be carried so far as to blot out entire nations, this may be an argument against war in any form, and in favor of a League of Nations, but it will not prove a deterrent to the nation that is using it. Wars usually occur as the result of some breach of convention or of promise. And even if we establish the convention that chemical warfare shall be forbidden, none the less we should keep ourselves at all times fully informed concerning it. Otherwise we are placing our country and our people at the mercy of any power that may see fit to break its word. So we chemists hold that the work done in providing this instrument for our army, and in organizing laboratories for service, offensive and defensive, in chemical warfare, should be maintained as a regular branch of our military system, whether we ourselves adopt the convention forbidding its use or not.

This has been said, and urged, and repeated, and printed, again and again, but the West Point traditions are stronger than our utterance, if not than our argument. The Chemical Warfare Service for the most part has been scrapped. It is about to be filed, rather than turned over to the Corps of Engineers—for there is hardly enough left to turn over—provided the present army reorganization bill now before the House is adopted. And even to-day to equip the Corps of Engineers with a competent chemical service would require, not only that much of the work be done over again, but that the Army should have something which the General Staff seems resolved not to have, and that is chemists!

CHEMISTS MUST EARN RECOGNITION

The Voice of Authority is not achieved by cultivation. It does not depend on pitch, nor on tone. It must be earned rather than trained. But sometimes its failure to function is due to the deafness of the auditors, and it may be that the Great American Ear is not yet sufficiently attuned to the call of Chemistry to hear even so urgent an appeal as that our Chemical Warfare Service be retained. In the bill for the reorganization of the Army now before Congress, the plans for the distant future are rosy enough. A great institute for scientific research is provided as an additional part of the Corps of Engineers, but for the present we chemists hold that if research is to continue, it must remain a separate corps. We recall the amazing wastes in preparing for war due to the lack of understanding of chemical reactions by men in authority, and we fear that if chemistry is now made a subordinate department of the Engineers, it will cease to function. The chief of the division, whose time in days of peace is devoted to the improvement of rivers and harbors and the digging of canals, is likely to detail the least useful engineer officers to direct chemical research. And that will mean, so far as chemical warfare is concerned, defenseless America once more!

THE BRIGHTER SIDE

So let's take a hitch in our belts and look to the morning. We are doing pretty well in industry and teaching. In pure research we are holding our own, and the outlook is good. There have lately appeared the Langmuir Postulates in regard to the constitution of atoms and molecules that are epoch-making. The lucid explanations of the nature of the nitrogen molecule as compared with its atom, of the characters of the halogens and the alkali metals, of carbon monoxide, and of other problems, are vastly illuminating and helpful. The researches of Professor W. D. Harkins of Chicago, always interesting and worth while, the great authority among chemists the world over achieved by the work of Theodore W. Richards of Cambridge, Mass., the clear thinking of G. N. Lewis of California, the masterly accomplishments of Edward C. Franklin on the ammonia system of acids, bases and salts, the constant and repeated flashes of light thrown from the brilliant mind of Wilder D. Bancroft—only to mention a few of our masters whose work suggests itself in passing—all are indicative of the fact that the chemists of America are alive—alive and awake. It is theory and not a condition that confronts us in chemistry, and unless we are sound in our theories of chemistry we are bound to fail.

In regard to teaching, we have the men and we have the students. We also have an advantage that is peculiarly noticeable in this country: we work together in both pure and applied science. In other words, chemistry is ready for industry. On the other hand, we are somewhat careless in the training of the imagination and the requirements of general culture demanded of our students. This is no appeal for chemical snobbery; it is rather an appeal for recognition of the fact that the man of research needs a trained imagination. And in industry especially it is needed that the chemist be proficient in that greatest of the arts, which is the art of living. In industry he meets men whose lines have not fallen in pleasant places. Here are those who have not had a fair chance, and he can give it to them. The chemist represents the scholastics and philosophy of manufacture. He can contribute the guiding hand, the thoughtful advice, the pleasant leadings that never can be put into the pay envelope. It is in the factory that his culture, his scholarship and his grace of living are most needed. Nor are we as generous as we might be in rewarding our professors with money, or with that which is equally important, the honors that are warranted by their posts of influence.

Industry has taken notice of chemistry, but it has not yet completely wedded itself to science by availing itself of its opportunities. There is need of many more general commercial laboratories than can find support. We need more industrial research. Again, we have not yet learned the need of men with trained scientific minds on boards of directors of corporations engaged in chemical manufacture. This is a serious defect, and its results are frequently shown in the inertia of industry in failing to profit by improvements that would make for great economies as well as for advancement in well-being. Most of us are familiar with large industrial establishments, the processes of which are based on chemical reactions, and these corporations are operated from the standpoint of salesmanship, banking and law. The company's legal advisor sits in council to pass upon contracts and procedure in dealings with men, but the chemical advisor who understands materials, and who, therefore, is responsible for the company's products and its good repute, is generally left out in the cold. American industry at large, with only a moderate number of exceptions, is still deficient in its calls upon the man of science to its councils.

NO SOLE RELIANCE ON A TARIFF WALL

Whenever such calls are made the American chemist has responded and has set himself to work with diligence. That so many of his efforts have been crowned with success is pleasant to contemplate—but the way of progress does not lie in contemplation alone. We are in the race with the wide, wide world. In some respects we are ahead, and in others we are behind. We cannot lean back and fold our arms in the belief that a high protective tariff will assure us success. We must maintain the co-ordination between pure science and that which is applied. We must hold up the hands of our great teachers and encourage them in their arduous task. We must increase the honors and distinction of their offices, and make the post of teacher as desirable as possible. We must do what we can to discover the exceptional man, and to create opportunity for him, because often the exceptionally gifted in research lack the gift of finding places for themselves. We must preach the gospel of chemistry, and bear its evangel to spots where its light is still unknown. And we must, in one way or another, conjure up the Voice of Authority so that it may speak for us!

Let us borrow an example from Arthur D. Little to show how the Voice of Authority might aid us. The water flowing incessantly over Niagara Falls represents the same power, the same energy, as would be obtained by the burning of a prodigious amount of coal. Except for the cost of installation and the slight charges for maintenance, it would be possible to use the power of that falling water in exchange for a colossal coal bonfire, developing the same energy expressed in terms of heat, for the edification of visiting brides and bridegrooms. Let us imagine this done, with miners working, and trains rushing constantly day and night, to feed this unheard-of bonfire. Suppose the Voice of Authority could present this picture to the public so that all could visualize the thousands of men at work, and the immense capital represented in the cost of the coal and its transportation—and all of it going up in smoke! Suppose it were made clear that none of that coal is being used to propel ships to and from Europe and trans-ocean markets, nor to give us warmth, nor to drive the wheels of industry, but that it is being spent, simply to keep our huge, international bonfire forever burning, and that people are paying for this spectacle in the increased cost of living, while the tremendous fund of power goes to waste. With this fact made clear—that that falling water represents an equivalent in millions of tons of coal which are charged to the people of this generation, these same people would soon declare themselves in favor of taking profit from that inexhaustible power for the benefit of the two countries it lies between, for the benefit of ourselves and Canada!

CHEMISTS MUST SHOW INTEREST IN PUBLIC AFFAIRS

We need the Voice of Authority to put a stop to waste of power, waste of fuel, waste of wood, waste of materials and waste of labor—and waste of men! We need this Voice to point out to us the way of progress.

I believe that we can conjure it up, not as the utterance of one individual, nor in the shout of thousands of voices, crying in unison. It will come, but rather in the benediction of things done. I believe we can accomplish it if, as chemists, we interest ourselves intensely in public affairs, struggling with all our might, both individual and collective, for the public weal, by doing this daily, and without thought of personal reward. If we dig into public affairs with diligence, preaching the gospel of chemistry with all the ardor of insistence shown by the Ancient Mariner in telling his weird tale, then, in time, our message is bound to be heard and heeded. Indeed, then, with God's help, we may advance toward a greater enlightenment, with a better art of living, and in a better-ordered world, where justice and peace abide.

American Electrochemical Society Meetings

At the last meeting of the board of directors of the American Electrochemical Society it was decided to hold the next meeting in Boston, April 8, 9 and 10, 1920. The American Institute of Electrical Engineers meets about the same time and a joint session will be held on April 10 on the subject of electrically produced alloys. Another feature of the meeting will be a symposium on colloids under the direction of the president, Wilder D. Bancroft.

Heat Treatment of 155-mm. High Explosive Shell *

By William J. Merten

HEAT treating the 155-mm. shell had been the cause of worry and delay in production in almost every plant manufacturing this size and type of projectile. Consequently, when the Twin City Forge & Foundry Co. entered upon large-scale production, I was informed from all sides that the man responsible for the heat-treating practice had a real metallurgical job, and consequently I was naturally guarding against any of the things which my experience had taught me to avoid, so that we could get results right from the start.

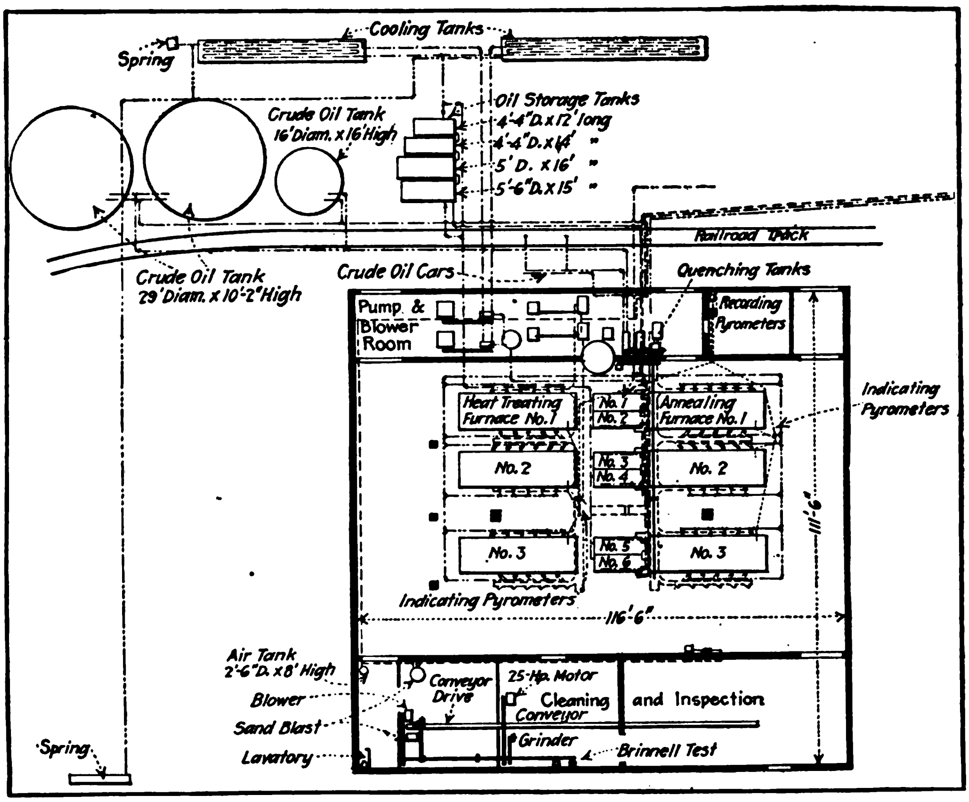

Cooling Tanks
Spring
Crude Oil Tank 16' Diam. x 16' High
Oil Storage Tanks
4'-4" D. x 12' long
4'-4" D. x 14' "
5' D. x 16' "
5'-6" D. x 15' "
Railroad Track
Crude Oil Tank 29' Diam. x 10'-2" High
Crude Oil Cars
Quenching Tanks
Pump & Blower Room
Recording Pyrometers
Indicating Pyrometers
Heat Treating Furnace No. 1
No. 1
No. 2
Annealing Furnace No. 1
No. 2
No. 3
No. 4
No. 2
No. 3
No. 5
No. 6
No. 3
111'-6"
Indicating Pyrometers
116'-6"
Air Tank 2'-6" D. x 8' High
Blower
Sand Blast
Lavatory
Spring
Conveyor Drive
25-Hp. Motor
Cleaning Conveyor
and Inspection
Grinder
Brinnell Test

FIG. 1. PLAN OF HEAT-TREATING DEPARTMENT AND AUXILIARY SERVICES

After a very thorough deliberation with our engineering department the following described equipment and layout was decided upon:

Equipment and Layout

Three batteries of oil-fired Ferguson furnaces with inclined floor and perforated arch were installed, each battery consisting of one heat-treating and one annealing furnace set in tandem, with automatic quenching tanks between them. These furnaces were placed in an available building near a disused cupola as shown in the general layout given in Fig. 1. The only change in the design of the furnace as furnished by the maker was to interrupt the continuous slope of the furnace floor some 4 ft. from the discharge end. This horizontal bottom comprised in effect a soaking chamber, permitting a limited degree of freedom of movement of the shells within this portion of the furnace, so that the final adjustment and equalization of heat in the body of the shell might be made by rolling it into such a position that the darker or cooler part of the metal might be exposed or subjected to direct impingement of flame. To this seemingly small and unimportant change I attribute more influence toward our success in heat treating than to any other single item in the chain of improvements over the style of equipment ordinarily used heretofore. Especially was this of extraordinary advantage in the drawing furnace, since an even temperature as low as, say, 1250 deg. F. is rather difficult to attain unless the shell may be juggled without having the rest of the load follow along by gravity and eject the one from the furnace before it has become "evenly heated." This one item of "even heat" is unquestionably the most essential factor and requirement to give satisfactory results.

Design of Quenching Tank

In designing the quenching tank we attempted to incorporate several ideas. First, we wished to reduce to an absolute minimum any inactive bodies of oil within the container during the journey of the hot shell. Second, we expected that the passage of the shell and the operation of the elevator would accomplish a correct circulation of the cooling medium without resorting to other mechanical stirring. Third and finally, we expected to simplify the problem of correctly directing the cool incoming oil and pumping the hot oil from the other extremity of the surface. The guides for lowering the shell into the oil are so constructed that the stirrup or carrier receives the shell base down and releases it at a point where the curvature of the elevator frame pushes the base clear of its support (shown in the general cross section Fig. 3). Lugs on a traveling chain then up-end the shell so that it is finally deposited nose down upon the chain conveyor, which elevates the shell out of the quenching bath. It is driven by a sprocket wheel and delivers the drained shell on the

---

*As conducted at the plant of the Twin City Forge & Foundry Co., Stillwater, Minn.

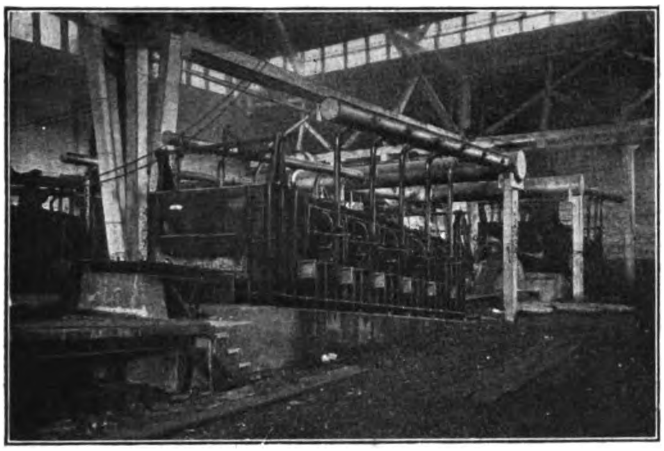


FIG. 2. OIL-FIRED HEAT-TREATING FURNACES

rear platform of the drawing furnace. This automatic tank successfully replaced not less than four men at each pair of furnaces at a point where the handling of hot metal is most inconvenient and difficult. The carriers are also provided with pockets to scrape up any scale from the bottom of the tank, dumping it upon a perforated shelf at the top of its travel, where oil is drained off and the scale may be removed.

OIL CIRCULATION AND COOLING SYSTEM

The planning of our cooling system was influenced by a happy combination of natural advantages. Two springs within our premises delivered a constant flow of about 90 gal. of water per min. at a temperature of about 45 deg. F. The water from these springs overflowed into wooden cooling tanks and furnished the medium whereby we kept the temperature of the quenching oil at the proper point. In each of these cooling tanks were placed 1200 ft. of 2½-in. pipe, the tanks themselves holding some 1200 gal. of water, constantly circulating at the rate of 90 gal. per min., which was the amount of water delivered by the springs above noted. Oil flowed through the piping at the rate of 150 gal. per min. per battery of quenching tanks. Cooled oil was in this manner returned to the tanks at a temperature of about 140 deg. F. when running continuously 24 hr. per day, the cooling water reaching a temperature of 100 deg. F. at the discharge end on hot summer days. In order to cool one shell per minute from 1550 deg. F., the temperature at which it was delivered from the heat-treating furnace, to about 400 deg. F., the temperature when entering the drawing furnace, about 2000 gal. of oil were found to be necessary in the tanks themselves, and this quantity of oil should be circulated at a rate of 150 gal. per min. in order that the oil might not exceed a temperature of 150 deg. The oil, after being pumped through the cooling coils, emptied into a sump tank, from where it flowed by gravity back into quenching tanks. A separate pipe line and pump were used to empty the oil from the quenching tanks into storage tanks. An analysis of the above data shows the following:

Having a good quenching medium (in this case Houghton Soluble No. 2) a bath of 2000 gal. of oil (roughly 16,000 lb.) circulating at the rate of 150 gal. per min. will dissipate the heat of 80 lb. of steel in the form of a shell, cooling this steel at the rate of 1100 deg. F. per min., and yet keep the oil at a temperature of 150 deg.

FUEL OIL STORAGE AND SUPPLY AND BLAST PIPING

The general drawing Fig. 1 shows location of these items of equipment. The fuel oil was stored in and supplied from a 25,000-gal. cylindrical tank about 25 ft. in height, giving a maximum pressure at the burners of about 9 lb. per sq.in. and an average pressure of about 5 lb. Air was supplied by three No. 45 blowers at about 8-oz. pressure per sq.in. The same drawing shows location of the pyrometer system, which was furnished by the Wilson-Maeulen Co. and gave satisfactory results. Pyrometer wiring was placed in conduit 1 ft. below ground, rising directly alongside the furnace. Indicators and tapalogs were supplied to each row of furnaces.

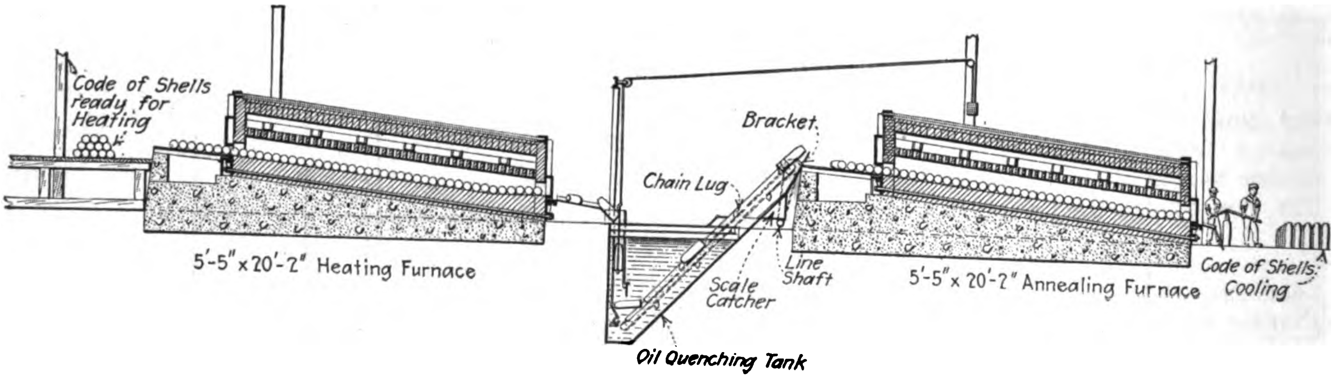

Code of Shells ready for Heating
Bracket
Chain Lug
5'-5" x 20'-2" Heating Furnace
Line Shaft
Scale Catcher
5'-5" x 20'-2" Annealing Furnace
Code of Shells Cooling
Oil Quenching Tank

FIG. 3. GENERAL CROSS-SECTION OF HEAT-TREATING PLANT

FUEL OIL AND QUENCHING OIL CONSUMPTION

Our fuel oil consumption was checked regularly and amounted to about 3.5 gal. per hr. per burner; 8 burners were used in each furnace, which gives a fuel consumption of 28 gal. of oil per furnace per hr., or per 60 shell. The consumption of quenching oil was due to its evaporation, plus leakage and the oil film adhering to shell carried out of the tank. This amounted to about 1 gal. of oil per 15 shell, a figure which well indicates the efficiency of our circulating and cooling system.

HEAT-TREATING PRACTICE

After rough turning, nosing-in of forging and rough turning the nose end, the shells are sorted into code lots, and piled or stacked in test lots upon the platform in the rear of the heating furnaces. Respective test lot numbers are stamped on the shell, these lots consisting of 700 pieces selected according to formula. This formula depended upon chemical analysis; after allowing a maximum carbon range of 0.06 per cent,

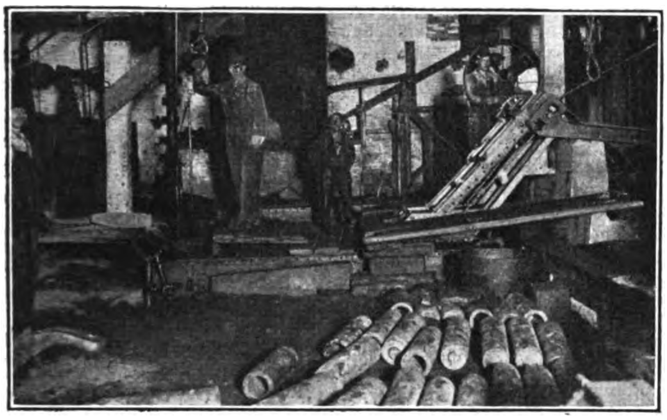


FIG. 4. OIL-QUENCHING TANK AND CONVEYOR

the maximum variation 3C + Mn must not be above 0.25.

The shell is then loaded on the rear platform of the heating furnace and rolled down its inclined bottom by gravity (Fig. 2), a furnace holding about 75. These are withdrawn at the discharge end at a rate of one every minute, thus giving a heating period of 1 hr. 15 min. to reach the required temperature of 1550 to 1575 deg. F. From this temperature they are automatically quenched in the tank described above and illustrated herewith, cooling to about 400 deg. F. before being deposited upon the rear platform of the drawing furnace. Quenched shells are immediately charged, reheated to the proper temperature and withdrawn. The annealing temperature is in the neighborhood of 1220 deg. F., depending upon the carbon and manganese analysis of the steel in that particular lot of shells. The time interval of the heating to this temperature is about the same as in the first furnace, namely, 1 hr. 15 min., although the shell was never withdrawn until a uniform heat was obtained.

Upon withdrawal the shell rolls into a chute which lands it in an upright position on the floor in front of the furnace, from where it is carried by tongs inserted in the open end of the nose to a cooling floor, where it is air-cooled in an upright position.

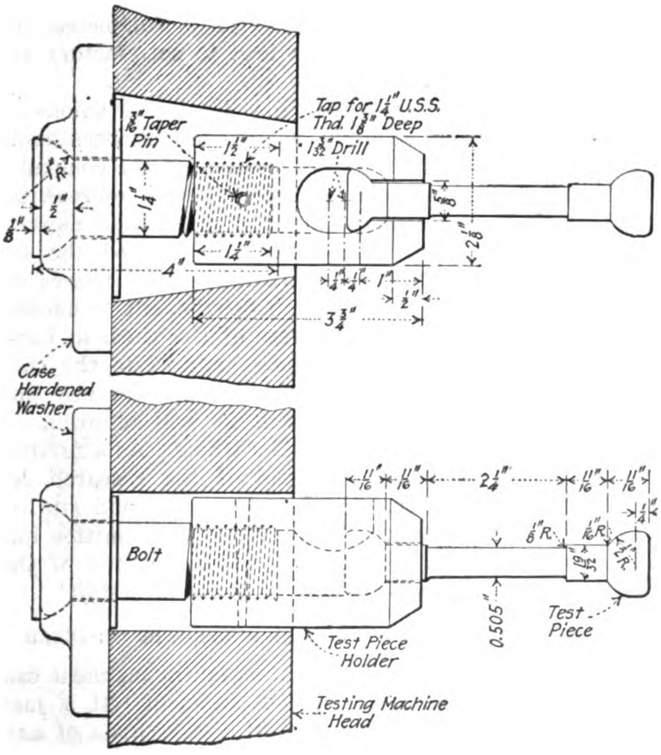


FIG. 5. DETAILS OF TEST PIECE AND HOLDER

When cool, two shells are taken at random for testing and the lot is released upon meeting the physical requirements of the specification for a 155-mm. high-explosive shell, each shell, however, being stamped with proper heat-treatment mark.

TEST SPECIMEN AND HOLDER

To facilitate the machining of test pieces and in order to avoid threading the ends, we adopted a specimen having ends with spherical shoulders. This is illustrated in Fig. 5, together with details of a holder of my design, which is in fact and principle a double ball joint. The use of this device eliminated side stresses to an extreme minimum and assured automatic alignment with more consistent results than any other holder or type of specimen in general use. Over 50 per cent of our broken test pieces show full cups, and we attribute this fact to the holder in use and its resulting perfect distribution of the tensile stresses.

CONCLUSION

The plant above described has a record of 100 per cent efficiency in heat treating, not a single failure being recorded for the entire contract. The results of our practice are therefore of a most gratifying character, and I attribute our success not only to the personal efforts of the officials and operatives, but more especially to a logically planned and correctly laid out equipment. We, therefore, feel that it may be of some value and benefit to give our methods this publicity, thinking that possibly it may add some useful information to that already available to the man who has to plan and develop an efficient heat-treating department.

Pittsburgh, Pa.

By-Product Coke Oven Operations

Some interesting figures compiled by the War Department comparing the operation of by-product coke oven plants in 1917 with operations in 1918 have been made public in the course of the probe in War Department expenditures being made by a committee of the House of Representatives. The percentage of capacity realized in production in 1917 averaged 88. In 1918 the average was 86.9 per cent. Plants realizing 100 per cent production in 1917 were the Ensley and Tuscaloosa plants of the Semet-Solvay Co., the Fairfield plant of the Tennessee Coal, Iron & Railroad Co., the South Chicago plant of the Semet-Solvay Co., the Sparrow's Point plant of the Bethlehem Steel Co., the Duluth plant of the Minnesota Steel Co., the West Duluth plant of the Zenith Furnace Co., the St. Louis plant of the Laclede Gas Light Co., and the Steelton plant of the Bethlehem Steel Co. In 1918 no plant realized 100 per cent production. In 1918 the per cent of capacity lost on account of no coal was 5.1. In 1917 the capacity lost on account of no coal was 18.75 per cent. In 1918 the toluol per ton of coal averaged 0.31 gal. In 1917 the toluol per ton of coal was 0.27 gal. The amount of ammonium sulphate equivalent per ton of coal in 1918 was 18.07. In 1917 it was 18.95.

Industrial Research in Small Establishments*

BY M. E. LEEDS

IN THE past few years, and particularly during the war, research in connection with industry has had much consideration. Most of our large technical societies have devoted sessions to its discussion and have listened to admirable papers on the subject. I hope not to retraverse the ground thus covered. In this audience the vital importance of research to our technical industries would not need arguing even if it had not been amply argued. In these discussions research has been considered as something to be carried on in large well organized laboratories, and for that reason possible only for large companies, for associated companies managing a co-operative laboratory or for Government laboratories and the like. I believe that this way of thinking of research unnecessarily restricts it, and that differently conceived its usefulness to small as well as large establishments would become evident and might result in its large extension.

RESEARCH IN A SMALL BUSINESS

The various activities covered by such titles as "Research," "Development" and "Technical Control" are those which should be assumed by a research department in a small business. In order to avoid a cumbersome name for such a department, I want to make a plea for a definition of technical research which some of you may think degrading. Doubtless you are accustomed to thinking of research as an adventure into the realms of the absolutely unknown. A department capable of research in this sense will be possible in a small business only when that business happens to have in it a real scientist. But every technical business (and what manufacturing business is not technical?) is continually confronted with the need of more information than is possessed by its regular staff in regard to processes, characteristics of materials, etc., and if it is to develop realizes that it must find new fields for its product and find new product to sell.

SUGGESTED DEFINITION OF INDUSTRIAL RESEARCH

The most advantageous solution of problems of this character cannot be left to people who are busied with the routine problems of sales and production. They can best be handled by a staff, even if a very small one, set aside for this purpose. I want to suggest that any department having such functions may be called a research department, and that industrial research may be defined for any given establishment as all that class of work which enlarges the technical horizon of the establishment beyond what is necessary for the routine production and test of its product.

You will note that this will make a sharp distinction between a research laboratory and a testing laboratory. I should not want to see a chemical laboratory, however large and elaborate its equipment or however highly trained its staff might be, called a research laboratory if its sole function happened to be routine analysis and check on the product. On the other hand, I should like to see any little room with even a very meager equipment and staff, perhaps only a single individual, called a research laboratory provided the functions of that individual and equipment were solely the improvement of processes, investigation of properties of materials new to the industry, development of new products, etc. And I should want to have it called a research department even if the research be chiefly carried on in libraries or other places for the purpose of bringing information, elsewhere well known, to an establishment to which that information happens to be new.

LARGE CAPITAL NOT NEEDED FOR RESEARCH FUNCTIONS

This conception of research widely recognized might be the occasion for many small industries to start research departments, which these industries now regard as possible only for large capital. In this sense many small industries already have individuals with research functions who have other duties as well and do not clearly recognize their research functions. Under these circumstances both the research and the other work suffer, and as the business develops research does not find the best relation to the work as a whole.

Research, development and technical control merge into each other at many points, and in all but very large establishments can probably best be carried on by a group working under one head. Why attempt lines of demarcation?

CO-ORDINATION OF RESEARCH WITH INDUSTRY NEEDED

In order that research may find its fixed and recognized place in industry it is desirable that it be carefully planned and controlled, and that its results be carefully watched. So far as I know, these two conditions of the successful co-ordination of research with industry have not been discussed. Control in the sense of control of the research in the laboratory after it has been decided on has had discussion, and I do not refer to it, but to the determination of the subjects which shall be investigated in the research department and the decision as to when the research is completed, or, in case it is one that does not lead to satisfactory results, when it shall be abandoned.

For some five or six years this class of decisions in connection with our research department has been made by a committee of which the president of the company, the head of the research department, and representatives of the sales, engineering and production departments are members. This committee, called the research committee, meets once in two weeks, passes on all new subjects for the research department to handle, listens to reports on the progress of the work in hand and passes on recommendations in regard to the conclusion or discontinuance of work. In this way the work of the research department is well co-ordinated with the needs of the business as a whole. As a further factor in co-ordination the head of the research department is one of the board of directors and sits on the executive committee. The research committee has nothing to do with the internal administration of the department, which is left entirely to its own staff.

COSTS SHOULD BE CHARGED AND RESULTS CREDITED

Records of the results of a research department can best be kept by the accounting department. It is just as important to know the cost of research as of any other department, and, as in other cases, the usefulness of the record depends to a very large extent on its subdivision. It is worth while to know what investigations contribute to business success and what ones do not.

---

*Read before the Philadelphia meeting of the American Physical Society (Oct. 11, '19).

Some years ago we worked out a plan of determining research cost and making credits to the department which has given us much valuable information. Each investigation undertaken has its cost record kept by the accounting department in the same way that a production order has. We of course do not ask our research men to register their time on a time clock or anything of that kind, but we do ask them to make a memorandum of the work on which they spend their time and turn in to the accounting department once a week a statement of the distribution of their time over the orders running in the department.

METHOD OF DETERMINING RESEARCH COSTS AND MAKING CREDITS

Similarly, expenses and costs of materials are kept, and when an investigation is closed its total cost is determined. If it happens to be one that has to do with manufacturing processes, such as test of new materials, etc., or development of new methods, it is either charged to general expense or to the expense of some particular product. If, however, it is a piece of work which results in the development of a new instrument or product for sale, it is treated in the same way that a new instrument developed and brought in by an outsider would be. The research committee decides how much royalty can properly be charged to the cost of the instrument, and then as each instrument is made the royalty is added to its cost and is credited against its cost account in the research department.

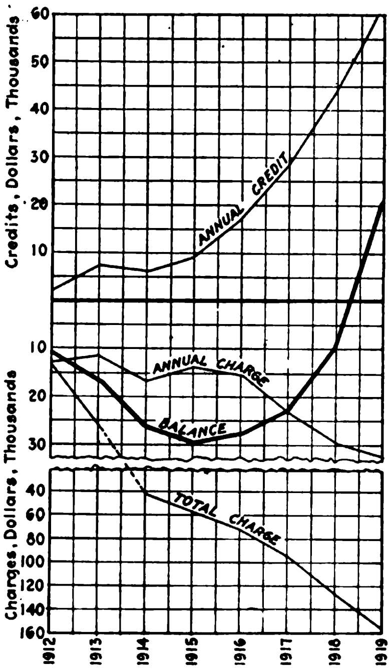


DIAGRAM SHOWING RELATION OF RESEARCH COSTS TO CREDITS

ROYALTIES CREDITED TO SUCCESSFUL DEVELOPMENTS PAY COST OF DEPARTMENT

In that way a continuous record of the usefulness of the research to the business is available. In cases of minor importance it is customary to discontinue credits when the cost has been covered. In cases where new products result they are allowed to run on indefinitely. Successful developments accumulate royalties that more than pay for the cost of their research and offset the costs of work that leads to nothing. The diagram shows the relation of annual and accumulated costs of research to the annual and accumulated credits since the department was given a distinct place. In a little over six years the total credits had equalled the total charges and the balance went to the credit side. On the books the account is closed out each year to profit and loss. It is carried forward as a memorandum account only. In the earlier years of the record the total volume of business done by the company was but a few hundred thousand dollars per year.

PLEA FOR DISTINCT DEPARTMENT HAVING ITS PROPER PLACE AS DO OTHER DEPARTMENTS

To summarize, I am making a plea for a conception and organization of research which will allow it to emerge as a distinct department in any growing technical business and take its proper place just as sales, production and accounting do. Any technical business ambitious to grow and render worthy service must in some way avail itself of research. Kenneth Mees and others have pointed out how industry in the past has developed around invention and research, although the distinctiveness of these functions was not clearly recognized, and in many cases they were not directly associated with the business which profited by them. Certainly an enterprise will have a more worthy and normal growth if its need for research is early and clearly recognized, and the research department will more easily find its proper relation to the business as a whole if it is established early and its place and functions are defined. After a business has assumed large proportions, and research functions are distributed in scattered manufacturing and engineering departments, it is difficult to gather them together and co-ordinate them.

THIS CONCEPTION OF RESEARCH NOT VIOLATIVE OF GOOD USAGE

Let me remind those of you who may think this conception of research degrading that the present scientific limitation of the word is modern and confined to the exact sciences. The Century Dictionary gives its definitions in this order:

1. Diligent inquiry, examination or study
2. Laborious or continued search after facts or principles
3. Investigation

and quotes from Cowper

> He sucks intelligence in every clime
> And spreads the honey of his deep research
> At his return—a rich repast for me

so I think the definition which I propose does not violate good usage. Even if it did, would not the possibilities of development and usefulness to industry which this definition allows justify it in the same way that Bryce, in his American Commonwealth, writing of the third quarter of the last century, said that the application of the name "university" to many institutions which were no more than colleges or in some cases high schools was a favorable sign because it showed an aspiration, and that where the aspiration existed the reality would follow? We all know to what a large extent this forecast has come true.

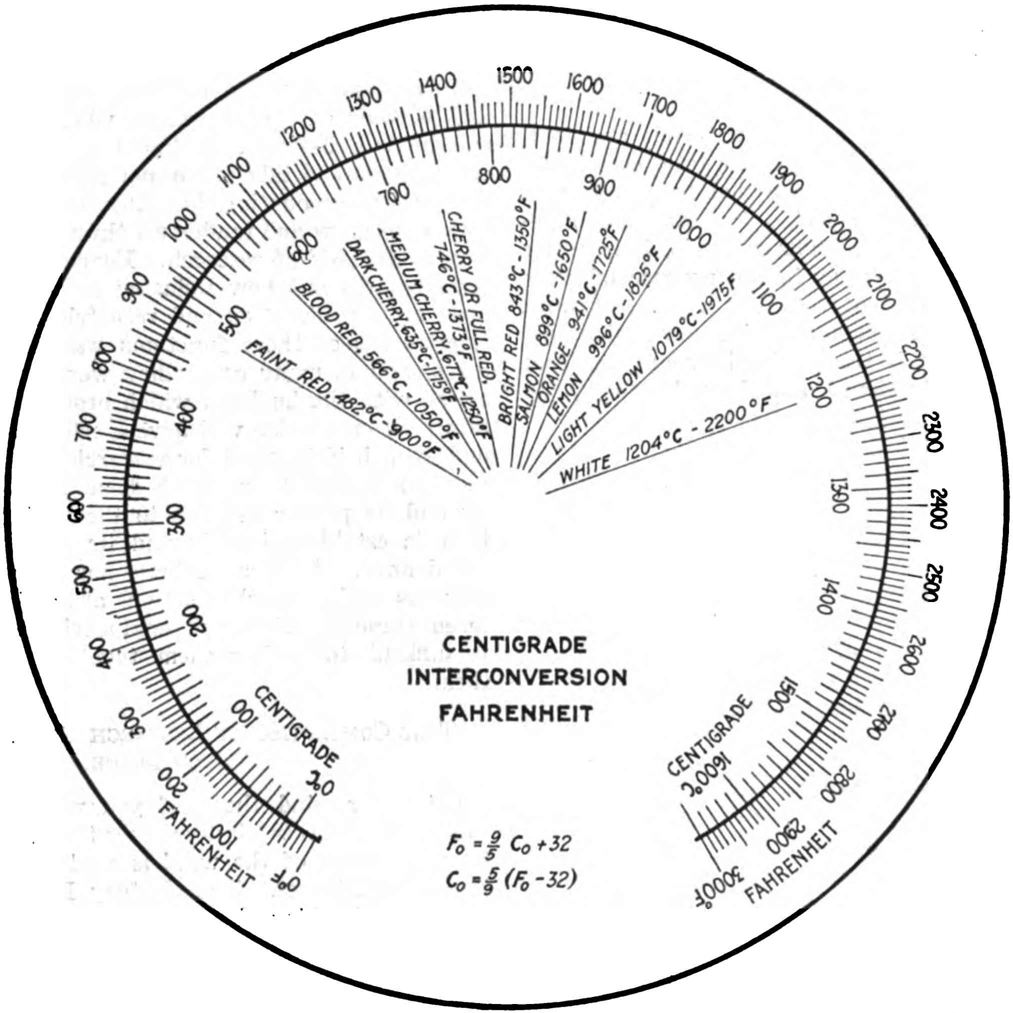
Leeds & Northrup Co.,
Philadelphia, Pa.

Convenient Chart in Chemical Works

There are any number of ways of assembling data for convenient use in chemical plants, one of which is shown below in the form of a chart with parallel temperature scales and an accompanying table. The Fansteel Products Co., Chicago, makes the information of easy access throughout its buildings by posting this chart on heavy cardboard in the laboratories, offices, furnace rooms and other locations where it is likely to be needed.

The radial lines in the top half of the scale giving the colors of metal opposite the corresponding temperature are especially valuable to the practical furnace operator in controlling the heats. At this plant, where a variety of furnaces are operating on the reduction of several of the rare metals, the table with atomic weights and melting points in both Centigrade and Fahrenheit is an added advantage.

Every one admits he knows the conversion factors for temperatures and the atomic weights of most of the elements, but with the chart at hand mental effort is saved and mistakes of memory eliminated.

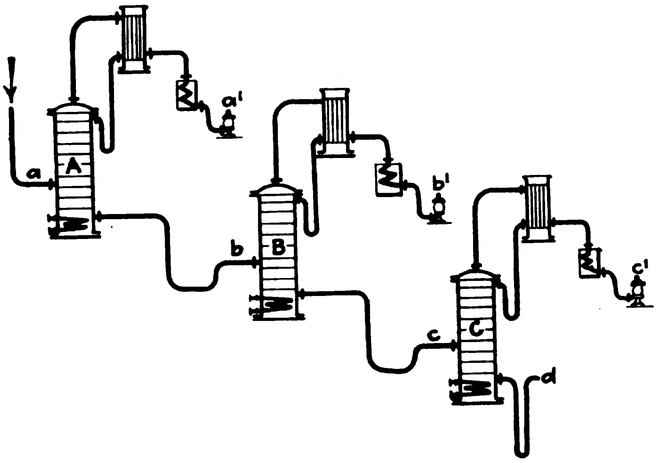


SYMBOL, MELTING POINT & ATOMIC WEIGHT OF THE CHEMICAL ELEMENTS

ELEMENT	SYMBOL	ATOMIC WEIGHT	MELTING POINT C°	MELTING POINT F°	ELEMENT	SYMBOL	ATOMIC WEIGHT	MELTING POINT C°	MELTING POINT F°	ELEMENT	SYMBOL	ATOMIC WEIGHT	MELTING POINT C°	MELTING POINT F°
ALUMINUM	Al	27.1	658.7	1217 7	HOLMIUM	Ho	163.5			RHODIUM	Rh	102.9	1950	3542
ANTIMONY	Sb	120.2	630.0	1166	HYDROGEN	H	1.008	-259	-434	RUBIDIUM	Rb	85.45	38	100
ARGON	A	39.88	-188	-306	INDIUM	In	114.8	155	311	RUTHENIUM	Ru	101.7	2450?	4442?
ARSENIC	As	74.96	850?	1562?	IODINE	I	126.92	113.5	236.3	SAMARIUM	Sa	150.4	[illegible]	[illegible]
BARIUM	Ba	137.37	850	1562	IRIDIUM	Ir	193.1	2350?	4262	SCANDIUM	Sc	44.1	?	--------
BISMUTH	Bi	208.0	271	520	IRON	Fe	55.84	1530	2786	SELENIUM	Se	79.2	[illegible]	[illegible]
BORON	B	11.0	[illegible]	[illegible]	KRYPTON	Kr	82.92	-169	-272	SILICON	Si	28.3	1420	2588
BROMINE	Br	79.92	-7.3	+ 18.9	LANTHANUM	La	139.0	810?	1490?	SILVER	Ag	107.88	960.5	1761
CADMIUM	Cd	112.40	320.9	609.6	LEAD	Pb	207.10	327.4	621.8	SODIUM	Na	23.00	97.5	207.5
CAESIUM	Cs	132.81	+26	79	LITHIUM	Li	6.94	186	367	STRONTIUM	Sr	87.63	>Ca<Ba?	....
CALCIUM	Ca	40.07	810	1490	LUTECIUM	Lu	174.0			SULPHUR	S	32.07	S I 112.8 S II [illegible] S III [illegible]	235.0 [illegible] 224.2
CARBON	C	12.00	>3600	>6500	MAGNESIUM	Mg	24.32	651	1204					
CERIUM	Ce	140.25	640	1184	MANGANESE	Mn	54.93	1260	2300	TANTALUM	Ta	181.5	2850	5160
CHLORINE	Cl	35.46	101.5	-150.7	MERCURY	Hg	200.6	-38.9	-38	TELLURIUM	Te	127.5	452	846
CHROMIUM	Cr	52.0	1520	2768	MOLYBDENUM	Mo	96.0	2500?	4500?	TERBIUM	Tb	159.2		
COBALT	Co	58.97	1480	2696	NEODYMIUM	Nd	144.3	840?	1544?	THALLIUM	Tl	204.0	302	576
COLUMBIUM	Cb	93.5	1700?	3090?	NEON	Ne	20.2	-253?	-423?	THORIUM	Th	232.4	>1 [illegible]	>[illegible]
COPPER	Cu	63.57	1083.0	1981.5	NICKEL	Ni	58.68	1452	2646	THULIUM	Tm	168.5		
DYSPROSIUM	Dy	162.5			NITRON RADIUM EMANATION	Nt	222.4			TIN	Sn	119.0	231.9	449.4
ERBIUM	Er	167.7			NITROGEN	N	14.01	-210	-346	TITANIUM	Ti	48.1	1800	3272
EUROPIUM	Eu	152.0			OSMIUM	Os	190.9	2700?	4900?	TUNGSTEN	W	184.0	3000	5430
FLUORINE	F	19.0	-223	-369	OXYGEN	O	16.00	-218	-360	URANIUM	U	238.5	< 1850	<3362
GADOLINIUM	Gd	157.3			PALLADIUM	Pd	106.7	1549	2820	VANADIUM	V	51.0	1720	3128
GALLIUM	Ga	69.9	30	86	PHOSPHORUS	P	31.04	44	111.2	XENON	Xe	130.2	-140	-220
GERMANIUM	Ge	72.5	958	1756	PLATINUM	Pt	195.2	1755	3191	YTTEBBIUM	Yb	172	?	....
GLUCINIUM	Gl	9.1	1350?	2462?	POTASSIUM	K	39.10	62.3	144	YTTRIUM	Yt	89.0	1490	2714
GOLD	Au	197.2	1063.0	1945	PRASEODYMIUM	Pr	140.6	940?	1724?	ZINC	Zn	65.37	419.4	786.9
HELIUM	He	3.99	<-271	<-456	RADIUM	Ra	226.4	700	1292	ZIRCONIUM	Zr	90.6	1700?	3090?

Synopsis of Recent Chemical and Metallurgical Literature

Continuous Rectification of Crude Benzol.—Mr. A. BARIL gives, in the September, 1919, issue of *Chimie et Industrie**, an interesting description of the Gennevilliers gas works plant for the continuous rectification of crude benzol. The apparatus employed consists of three columns, each provided with its own heating arrangement. The crude benzol enters column *A* at *a*. By heating, the first distillate (CS_2, etc.) is separated at a^1. Here testing apparatus is provided for the purpose of controlling the operation of the column. The partially rectified crude remaining in *A* enters column *B* at *b*. The heating of this column is so regulated that the pure benzene fraction is collected at b^1. The product remaining in *B* passes through *c* to the column *C*, where, by a similar procedure, pure toluene is obtained at c^1; the residual product, solvent naphtha, being drawn off through *d* to suitable storage tanks.



SCHEMATIC ARRANGEMENT FOR THE CONTINUOUS RECTIFICATION OF CRUDE BENZOL

Allotropic Nitrogen.—The October number of the *Catalyst*[1] contains the following discussion on allotropic nitrogen by Dr. HENRY LEFFMANN:

"Until the discovery of the so-called 'noble' gases—the argon group—nitrogen was generally considered by chemists as the most indifferent of the elements as far as properties in the free state are concerned. In contrast with this is the fact that it occurs in nature in many combinations with a variety of elements, and while direct combination is difficult to bring about, many artificial compounds can be obtained by indirect means, among which is the effect of nascent state. Moreover, many of the compounds of nitrogen, however obtained, are not easily decomposed; even the associations with hydrogen and carbon, which from theoretic consideration would seem to be loose unions, are quite stable.

"Many years ago, Professor H. E. Armstrong expressed the view that an allotropic form of nitrogen characterized by much higher affinity than the common form would be obtained, and it seems that such a form has been discovered. Allotropism is an interesting phenomenon and several striking examples have long been known. Two of the most interesting are seen in phosphorus and oxygen. It is curious that the active and inactive forms of these elements are reversed as to frequency of occurrence. Phosphorus, as obtained in the free state by standard processes, is always the active form, oxygen under similar conditions always the inactive form, with, it is true, often minute amounts of the active modification.

"In 1911 Strutt published in the *Proceedings of the Royal Society* (1911, vol. 85, p. 219), an account of experiments in which nitrogen was subjected to the action of electrical discharges by which new qualities were acquired. The methods and results given in this paper were in outline as follows: Pure nitrogen from any source subjected to jar discharge undergoes a change by which it acquires a short phosphorescence and much increased combining power, combining directly with phosphorus, also with sodium and mercury, at a gentle heat, forming, in the case of last named, an explosive compound. The action on phosphorus is accompanied by the formation of much red phosphorus. (In this is to be noted some analogy to the action of iodine on phosphorus, in which case red phosphorus is also formed.) The modified nitrogen attacks nitric oxide (NO), forming, strangely, nitrogen dioxide (NO_2).

"It attacks acetylene and many hydrocarbon haloids, setting free the halogen and forming cyanogen.

"Strutt's inferences were at once challenged by several investigators, especially in Germany, and for some years a running fire of criticism and counter-criticism has been going on. On Feb. 21, 1918, Strutt delivered before the Chemical Society a lecture on the subject in which he repeated some of his experiments and gave the results of later investigations, especially in the light of the objections that had been made. Among the most important of these objections is that the nitrogen he used was not pure, and that the effects observed were due to the impurities. Oxygen was claimed as the principal impurity. Strutt's lecture appears in the publication of the Society (*J. Chem. Soc.*, 1918, vol. 113, p. 200). He makes the following statements: Pure nitrogen does not give the modification, but traces of many other substances suffice to activate it. Oxygen is one of these, but hydrogen sulphide, ethylene and methane are also active. It seems, then, that a sort of catalysis is essential.

"One of the most marked indications of the change in the nitrogen is that it acquires a peculiar glow under the influence of the electric discharge, which persists for a brief period after the discharge ceases. Here there seems to be some analogy to phosphorus, which is a member of the nitrogen group. The subject is interesting, and in the increase of work in pure science, which must soon begin under the conditions of peace, further interesting data concerning it will probably be obtained. Strutt obtained nitrogen mostly from liquid air.

"It is worth noting that Briner and Baerfuss (*J. Chim. Phys.*, 1919, vol. 17, p. 71), in studying the production of ammonia under the influence of arc discharges, did not observe any of the effects on the nitrogen such as Strutt records."

---

*La rectification continue des benzols. A. Baril. *Chimie et Industrie*, vol. 2, No. 9, September, 1919, pp. 1013-1016.

[1] The *Catalyst* (official bulletin of the Philadelphia and Delaware Sections of the American Chemical Society), vol. 4, No. 8, p. 6; October, 1919.

Recent Chemical and Metallurgical Patents

American Patents

Complete specifications of any United States patents may be obtained by remitting 10c. each to the Commissioner of Patents, Washington, D. C.

Process of Recovering Quicksilver From Its Ores.—HENRY W. GOULD of San Francisco, Calif., improves the process of condensing quicksilver vapors which are liberated from roasting ores. The vapors from the furnace are passed through a dust chamber and thence into an inclined conduit made of terra cotta or tile pipe, which acts as a condenser, and the condensed quicksilver is collected from a receiver at the lower end of the conduit. In order to assist in the condensation and, principally, to prevent the precipitation of soot, dust and ash, air under pressure is introduced into this inclined conduit through a nozzle and in the direction of the flow of gases through the conduit. This prevents to a large extent the precipitation of soot, and the condensed quicksilver will readily coalesce. The conduit is of sufficient length to insure the condensation of a large portion of the quicksilver. Brick condensing chambers of the usual form are also provided. (1,315,663, Sept. 9, 1919.)

Process for the Extraction of Sulphur From Metal Sulphides.—MAX HELBIG of Fredriksstad, Norway, obtains sulphur from pyrites by mixing pyrites, apatite, coke and quartz in proportions calculated to correspond to the equation

$$4FeS_2 + Ca_3P_2O_8 + 5C + 3SiO_2 = 8S + 2Fe_2P + 5CO + 3CaSiO_3.$$

An enclosed electric furnace to which is connected a condenser is used to carry out the process. (1,315,-496, Sept. 9, 1919.)

Method of Briquetting Finely Pulverized Iron Ore.—J. R. H. A. LAMMERHIRT of Hoerde, Germany, has invented a process whereby finely pulverized ferroso-ferric oxide of iron or magnetic iron ore concentrates may be formed into a briquet. The method consists of adding iron in the form of shavings and finely pulverized ferric oxides or oxyhydrates in a small proportion to the oxide or ore to be briquetted. The process is most efficient if the iron oxide be slightly moist. (1,315,315, Sept. 9, 1919.)

Shellac-Naphthalene Plastic Composition.—In the manufacture of shellac-impregnated paper and cloth for electrical insulating purposes, it has been customary either to mix the shellac with oil, which is a difficult matter, or to dissolve the shellac in wood alcohol. In the latter case, it is found that the presence of wood alcohol, which can be completely removed from the shellac only with great difficulty, lowers the dielectric strength of the product. JAMES P. A. MCCOY of Wilkinsburg, Pa., has found that a mixture of shellac and naphthalene is fluid when heated and forms an excellent impregnating and binding material. The resulting products are flexible, unless heated sufficiently to volatilize the napthalene. If permanently flexible products are desired, the naphthalene should be replaced by naphthols or other naphthalene derivatives (except chloronaphthalene). (1,317,204; assigned to Westinghouse Electric & Mfg. Co.; Sept. 30, 1919.)

Recovery of Carbon Bisulphide in Benzene Distillation.—The percentage composition of that fraction of light oil known as "90 per cent benzol" is about 70 per cent benzene, 24 per cent toluene, including a little xylene, and 4 to 6 per cent carbon bisulphide and light hydrocarbons. Attempts to recover the carbon bisulphide by fractional distillation have been unsucessful, since the boiling points of pentane (the principal light hydrocarbon in this fraction) and CS_2 are so close together, i.e., 37 and 46 deg. C. respectively. By treating this fraction with a halogen in the presence of a suitable catalyst, HERBERT H. DOW obtains a mixture of CS_2 and a halogen derivative of pentane having a boiling point sufficiently above that of CS_2 to make practicable the process of separation by fractional distillation. For example, when chlorine is used pentyl chloride ($C_5H_{11}Cl$; b.p. 160 deg. C.) is formed. (1,317,359; assigned to the Dow Chemical Co.; Sept. 30, 1919.)

Purification of Nitrous Oxide.—Ammonium nitrate is heated to 250 deg. C. in an aluminum retort. The gases evolved pass through a condenser and are then purified by scrubbing with acid potassium permanganate solution, 10 per cent sodium hydroxide and 20 per cent sulphuric acid. All impurities are eliminated, with the possible exception of a trace of nitric oxide, which disappears when the gas is allowed to stand for a period of 48 hr. in an iron or other metallic container. (1,315,354; ANDREW R. WARNER, assignor to Lakeside Hospital, Cleveland, Ohio; Sept. 9, 1919.)

British Patents

Complete specifications of any British patents may be obtained by remitting 25c. each to the Superintendent British Patent office, Southampton Buildings, Chancery Lane, London, England.

Picric Acid.—Picric acid is obtained by nitrating with nitric acid and concentrated sulphuric acid, the dinitrophenol produced by treating 1-chlor-2.4-dinitrobenzene with caustic alkali. (British Patent 9962—1915. L. G. BADIER and L. B. HOLLIDAY, both in Huddersfield; May 14, 1919.)

Calcium Nitrate.—In the production of calcium nitrate by the reaction of calcium chloride on sodium nitrate in solution, the calcium chloride is employed in excess, for instance an excess of 10-20 per cent, and the mixed solution is evaporated, for instance until its boiling point is 130-140 deg. C., and then cooled or allowed to cool, for instance to 60 deg. C., the sodium chloride which separates during these operations being removed; then the solution is diluted, for instance until its boiling point would be about 128 deg. C., and is then further cooled, whereupon calcium nitrate crystallizes out and is washed with water or calcium nitrate solution, and, if desired, may be recrystallized. In recrystallizing, a solution of a boiling point of about 121 deg. C. may be employed, and the mother liquor may be used for washing the crystals first obtained or for diluting the original solution prior to the first crystallization. (British Patent 10595—1915. S. SMITH and AMMONIA SODA CO., Northwich; May 14, 1919.)

Nitrogen Oxides.—For obtaining nitrogen oxides by catalytic oxidation of ammonia, the catalysts employed consist of a mixture of iron oxide, oxide of metal electronegative to iron and reduced but not fused under the working conditions, such as copper and oxide of an alkaline-earth metal. Hydroxides, carbonates, or other salts may be employed instead of oxides if they are converted into oxides under the working conditions and do not introduce contact poisons. In the examples a mixture of ferric and copper nitrate is precipitated by sodium hydrate or carbonate, and slaked lime is mixed with the washed precipitate, the mixture being molded, dried, and calcined; and a mixture of ferric, copper, and calcium nitrates is precipitated in a similar manner, and the precipitate is similarly treated. (British Patent 10781—1915. E. B. MAXTED and G. R. RIDSDALE, both in Walsall, Staffordshire; May 14, 1919.)

Picric Acid.—In the production of picric acid by sulphonating phenol and nitrating the sulphonation products, the temperature of nitration is not allowed to exceed 118 deg. C., and is maintained for approximately 8 hours. The temperature is preferably maintained at 110-118 deg. C., either by external regulation of temperature or by commencing the reaction at 80-95 deg. C. (British Patent 14367—1915. N. H. GRAESSER and A. W. TITHERLEY, Ruabon, Denbighshire; March 14, 1919.)

Acetone, Acetates and Pyruvates.—Method of making acetates and pyruvates by the action of the mold Amylomyces rouxii on a starchy or sugary mash in the presence of an alkaline-earth carbonate. The pyruvates can be converted into acetates by oxidation. The salts can be converted into free acetic acid and then into acetone; or acetone may be obtained directly by the destructive distillation of the salts, air or oxygen being admitted, if desired, to the apparatus in which the distillation is effected. (British Patent 14607—1915. A. FERNBACH, Paris, France, and E. H. STRANGE, London, England; May 14, 1919.)

Explosives.—Methods of preparing explosives which consist in gelatinizing nitrocellulose-nitroglycerine explosives containing more than 50 per cent of nitroglycerine at ordinary temperatures by the addition of 0.1 to 1.0 per cent, calculated on the nitroglycerine content, of aromatic nitro-compounds such as mono-, bi- and tri-nitrotoluenes, mononitronaphthalene, dinitrobenzine, nitroxylenes, and mixtures of these, also "liquid trinitrotoluene." One example contains nitroglycerine 89.8 per cent, soluble nitrocellulose 8.7 per cent, liquid trinitrotoluene 0.9 per cent, and calcium carbonate 0.6 per cent. (British Patent 14656—1915. W. RINTOUL, D. CROSS, and NOBEL'S EXPLOSIVES CO., Ardeer factory, Stevenston, Ayrshire; May 14, 1919.)

Explosives.—Methods of preparing explosives which consist in gelatinizing nitrocellulose-nitroglycerine explosives at ordinary temperatures by the addition of 0.1 to 1.0 per cent, calculated on the nitroglycerine content, of substances of the following classes: Urethanes or esters or carbaminic acid, anilides, substituted ureas, condensation products of glycol and other polyhydric alcohols with aldehydes, homologues of oxanilic ester, and the well known solvents of nitrocellulose such as acetone, acetic ester, and amyl acetate. One example contains nitroglycerine 91.6 per cent, soluble nitrocellulose 7.5 per cent, formanilide 0.2 per cent, formotoluidide 0.1 per cent, and calcium carbonate 0.6 per cent. (British Patent 14655—1915. W. RINTOUL, D. CROSS, and NOBEL'S EXPLOSIVES CO., Ardeer factory, Stevenston, Ayrshire; May 14, 1919.)

Personal

Mr. H. R. **BEARD**, formerly chemist with the Nitrate Division, Ordnance Department, has been appointed an instructor on the staff of the University of Wisconsin, Madison, Wis.

Lieut. J. H. **BECQUE**, who has been stationed at the U. S. Chemical Plant, Saltville, Virginia, has received his honorable discharge from the Army, and has accepted a fellowship at the Mellon Institute, Pittsburgh, Pa.

Mr. M. J. **BLEW** has been appointed assistant professor in analytical chemistry at the University of Louisville, Louisville, Ky.

Mr. **JOHN G. BRICKEY** has been recently employed as research chemist by the Miner Laboratories, Chicago, Ill.

Dr. C. B. **CLEVENGER**, recently with the U. S. Soil Survey, has been appointed on the staff of the University of Wisconsin, Madison, Wis.

Mr. **FERDINAND P. EGEBERG**, a distinguished Norwegian engineer, is at Salt Lake City, on his way to Arizona, where he will study methods of flotation.

Mr. J. B. **FROST**, formerly with the Semet-Solvay Co., has accepted a position on the staff of the Burgess Laboratories, Madison, Wis.

Mr. **SAMUEL HERSCH**, formerly metallurgist at the Rear Axle plant of the Maxwell Motor Co., Inc., Detroit, is now connected with the Forest City Machine & Forge Co., of Cleveland, in the same capacity.

Mr. **ROBERT M. KEENEY** has been retained by the Westinghouse Electric & Manufacturing Co. in a consulting capacity in connection with the development of ferro-alloys now being undertaken by the Westinghouse company.

Dr. S. C. **LIND**, formerly of the University of Michigan, has succeeded Dr. R. B. Moore as chief of the Colorado Station of the Bureau of Mines. Dr. **MOORE** has been appointed chief chemist and chief of the Division of Mineral Technology of the Bureau and will be located in Washington, D. C.

Mr. V. W. **MELOCHE** has accepted an appointment on the staff of the University of Wisconsin, Madison, Wis.

Mr. G. H. **MONTILLON** has been appointed an instructor in chemical engineering at the University of Wisconsin, Madison, Wis.

Mr. F. G. **MOSES** has resigned from the staff of the Salt Lake City Station of the Bureau of Mines and is now with The Barrett Co., with headquarters at Salt Lake City, Utah.

Dr. **HUBERT L. OLIN**, well known to the industry for his work in the chemistry and engineering of fuels, has been appointed chief of the department of industrial chemistry and chemical engineering, Iowa University, Iowa City, Ia.

Mr. J. **BENJAMIN PARKER**, metallurgist, Salt Lake City, Utah, has accepted a position as flotation engineer with the Interstate-Callahan Mining Co., Wallace, Idaho.

Mr. ROSS **PARMELEE** has accepted a position with the Redmanol Chemical Products Co., and will be employed chiefly on research work in Redmanol. Previous to entering the Chemical Warfare Service Mr. Parmelee was plant manager for the Armour Soap Works, Chicago, Ill.

Mr. **FRANK M. SMITH**, for many years, in fact since its construction, in charge of the East Helena smelter of the American Smelting & Refining Co., has become assistant director of the Bunker Hill & Sullivan Co., with offices in Spokane. Mr. Smith's wide knowledge of Western ore producers will be utilized by the new company in a vigorous cultivation of the custom smelting business.

Mr. E. **GYBBON SPILSBURY** is on his way to Brazil to study the question of establishing steel works in that country, and expects to be absent three and one-half months.

Mr. E. P. **Stenger** has resigned from his position as metallurgist for the Sheldon Spring & Axle Co. to accept a position on the staff of Thompson & Black, financial accountants and engineers, Detroit, Michigan.

Mr. **John E. Valentine** has accepted a position as chemist with the Synthetical Laboratories of Chicago, Ill. Mr. Valentine was previously employed in the Chemical Warfare Service, at Edgewood Arsenal.

Current Market Reports

The Non-Ferrous Metal Market

New York, December 12, 1919.

For the last week the copper market has been fairly steady, today's price being 18¾c. for spot. Fortunately, so far as supply is concerned, the curtailment of production because of fuel shortage is offset by exceptionally heavy stocks. With favorable financial conditions the export business would be heavy, as Europe stands in great need of copper. The demand for lead is strengthening as the offerings grow lighter. The market is rising, with brisk business at 7¼c. for spot. Indications are that Great Britain will be a steady buyer of zinc. The New York price was 8.70c. for spot. Other metals are quoted as follows:

	Cents per Lb.
Aluminum, 98 and 99 per cent	32.00—33.00
Antimony	9.62½
Copper, electrolytic	18.75
Lead, New York, spot	7.25
Lead, E. St. Louis, spot	6.90
Tin, Straits, spot	52.50
Zinc, New York, spot	8.70
Zinc, E. St. Louis, spot	8.37½
Copper sheets, hot-rolled	28.50
Copper bottoms	37.00
Copper rods	25.75
Copper wire	21.50
High brass wire and sheets	24.25
High brass rods	27.00
Low brass wire and sheets	26.25
Low brass rods	27.00
Brazed brass tubing	30.50
Brazed bronze tubing	40.75
Seamless copper tubing	32.00
Seamless bronze tubing	34.50
Seamless brass tubing	30.50

OTHER METALS

Bismuth, wholesale	lb.	$3.25—......
Cadmium	lb.	2.50— $3.00
Cobalt	lb.	1.80—......
Magnesium	oz.	.12½—......
Nickel (ordinary)	lb.	.42—......
Iridium	oz.	250.00—300.00
Palladium	oz.	150.00—......
Platinum	oz.	150.00—......
Silver	oz.	1.32½—......

SCRAP METALS

	Buying at Cents per Lb.
Aluminum, cast	22½—23½
Aluminum, sheet	21½—26
Copper, heavy machinery comp.	14½—14¾
Copper, heavy and wire	13½—13¾
Copper, light and heavy bottoms	12½—12¾
Brass, heavy	7½— 8
Brass, light	5½— 6½
Lead, tea	4½— 4¾
Lead, heavy	5½— 5¾
Zinc	4½— 4¾

The Iron and Steel Market

While the union bituminous coal miners began straggling back to work on Thursday, Dec. 11, following the Indianapolis settlement, it is probable that the iron and steel industry will feel the pinch of coal and coke shortage with increasing severity for a week or two after that date. A few steel mills and quite a number of finishing departments had closed from lack of coal at the time of the coal wage settlement, but quite a number of others are likely to be forced to close through their stocks being exhausted. The coal distribution regulations do not contemplate the distribution of more coal than enough to support a 50 per cent operation of by-product coke ovens and of steel mills, and there is no assurance of even such a quantity being actually furnished. A 50 per cent restriction in the production of beehive coke only began as the wage settlement was made, a 25 per cent restriction having been in more or less force for a few days previous, and coke from beehive ovens is usually in transit from one to two weeks, so that with the removal of the coking restrictions entirely problematical the blast-furnaces may have a coke shortage until the end of December, and possibly even longer.

SCARCITY OF STEEL

Appearances of steel being scarce have multiplied, but the coal strike itself can hardly be regarded as a cause of steel being scarce, since such observation as can be made rather suggests that the shortage of coal affects the consumption of steel more than its production. Many manufacturing consumers of steel have been closed by the coal shortage or the coal-consuming regulations.

Cases of buyers being in dire need of steel are impressive by reason of the severity of the condition rather than by reason of the tonnages required. Steel is much scarcer among jobbers than among manufacturing consumers, and a rough estimate is that normally only about 10 per cent of the steel produced passes through the hands of jobbers. In some quarters claims are made that mills have been favoring manufacturing consumers to the disadvantage of jobbers.

Fancy prices are being bid for steel, but only for a relatively small proportion of the various descriptions of finished steel turned out by the mills. There is much mention of sales of steel at prices above the March 21 schedule, but it seems certain that in all cases in which any considerable advance has been paid over March 21 prices, say an advance or premium of more than $5 a ton, the delivery involved is prompt and the tonnage relatively small.

STEEL CORPORATION ADHERES TO SCHEDULE PRICES

The United States Steel Corporation adheres very firmly to its doctrine that steel should not be allowed to advance in price above the March 21 schedule, and it carries its theory into practice, seeing that its unfilled tonnage at the end of November is reported at 7,128,330 tons. This indicates an increase of 655,662 tons during the month, and as the shipments were not far from 800,000 tons the corporation is seen to have sold nearly 1,500,000 tons of its products in the month, in no case charging more than the March 21 price. Nor is the Steel Corporation hopelessly oversold, as some producers predicted recently would be the case if it continued to sell at the old prices, since on a conservative estimate of its prospective output, with gains bringing the output in March up to the pre-strike rate, about 85 per cent of rated capacity, the shipments by the middle of June would be approximately equal to the unfilled obligations now reported.

Several of the large independents are committed to the same price policy as the Steel Corporation, while many of the small independents are seeking advanced prices. As they can furnish little tonnage against fresh sales before about April 1, they are in some instances refraining from selling at all.

Foundry pig iron has advanced in some markets in the week, valley and Philadelphia quotations being up $2 a ton, but bessemer and basic are unchanged. Quotations on foundry iron now are: Delivered Philadelphia, $40.10; at furnace, Buffalo, $39; Cleveland, $33; Chicago, $33; Birmingham, $34. The valley market stands at $35 to $38 for foundry, depending on delivery, with basic at $33 to $34 and bessemer at $35.

The Chemical Market

New York, December 12, 1919.

The demand for *heavy chemicals* remains strong, but trading is light owing to small stocks. Many firms have contracted three or four months into next year, but no further because of the unsettled conditions. The coal shortage which has slackened production will be felt in the market in a few months by buyers of these chemicals. *Coal-tar products* have advanced in some lines, with a large export demand that is being turned aside in favor of the domestic market. *Vegetable oils* have been dull, the buyers and sellers each looking at the market from a different angle. *Naval stores* have been firm, with a drop in some items in sympathy with the Southern market prices.

The *crude rubber* market has been inactive, except for a few small lot exchanges. *Flotation oils* are firm, with a continued brisk inquiry. *Ammonium sulphate* went up and is now quoted at 1⅞-2½c. per lb.; there is a scarcity of raw material and the demand at present exceeds the quantity on hand.

The demand on *sodium bichromate* is excessive, and there is very little of it on hand even at 36-45c. per lb.

Formaldehyde and *caustic soda* have moved to the front both in demand and price, formaldehyde being listed at 32-35c. per lb., caustic at $3.80-3.85 per cwt. Both can be obtained only in small lots. *Glauber's salts* have been active at $1.50-2.25 per cwt. *Borax* at present is in large demand, increased from 8-8½c. per lb.

Benzol jumped from 25-29c. per gal. to 27-31c., and *toluol* rose from 30c. per gal. to 32c., with large demand for both. *Dimethylaniline* is quoted at 80-85c. per lb., while *aniline oil* can be had in carlots at 32c. per lb., with Japan a heavy buyer. *Alpha naphthol* and *paratoluidine* have been sold out for the first half of next year, with Japan a heavy buyer.

Denatured alcohol jumped to 68-70c. per gal. and no quotations on this item will be given after the first of the year. The demand has been both foreign and domestic and it is difficult to obtain this material, as all available will be used to fill contracts.

Paraffine waxes: Crude match wax (white) 105-110 m.p., is off the market, refined 118-120 m.p. jumped 9c. per lb. against 8½c. of last report, and refined 128-130 went up a cent to 10½c. per lb. This market has been active in exporting to Europe, Japan and South America.

Rosin B-D dropped to a low mark of $17-17.50 for 280 lb., against $17.30 of previous quotations, and *rosin E-1* sank to $17.55-18.25 per 280 lb., from $18.35-18.95 of last week. *Spirits of turpentine* took a jump from $16-17 per 280 lb. to $17-17.50, while *wood turpentine*, steam distilled, went to $1.68 per gal., compared with $1.50 of former report.

FERRO-ALLOYS

There have been no new developments recently, market prices in general continuing to rise and demand remaining about the same. Deliveries are a hazard, due to the coal shortage, and some plants have already cut down on their output. Despite these adverse conditions, however, the market continues to step along at its usual pace.

The uncertainty as to what tariff regulations will be imposed on *tungsten* has killed this market. *Scheelite* continues at $10-15 per unit, and there has been no change in *wolframite*, still quoted at $7-8 per unit.

Ferromanganese, 78-80 per cent Mn, has been active, with heavy demand and plentiful supply, at the following quotations: English at $110, domestic $120 per gross ton. The difficulty of obtaining freightage on manganese ore is holding up this item, which has been in large demand for furnace purposes, at 60-70c. per unit, 45 per cent and over, against 55c., the low market of last week. *Chrome ore*, 48 per cent and over, has jumped from 68c. to 70c. per unit. It is the opinion of some that a new price list will be effective about the first of the year. *Spiegeleisen* is quoted at $38 spot, $40 futures, f.o.b. furnace, with demand slightly increasing.

Government prices prevail on *coke*, with foundry nominally quoted at $7-8 per net ton, compared with last week's quotation of $5-6. *Furnace coke* has also gone up to $6-7, against $4-5 of the previous report. Exporting in this item has fallen off and all available material is being husbanded for domestic use in place of coal wherever possible. A serious shortage of *blanc fixe pulp* is accountable for the rise from $30-40 to $40-60 per ton, which is the present quotation. *Barytes white floated* remains firm at $30-40 per ton, with a large domestic demand which is being filled immediately, the surplus being exported.

An unprecedented demand on *feldspar* has left this item in the position of being quoted nominally at $13.50-18 per ton, which is the limit set by the Government. It is practically impossible to obtain any of this material, as the supply, which is greater now than it ever has been before, is going to fill up back orders. There has been no change in the general conditions of *talc*, domestic being quoted at $55-70 per ton, while foreign grades are listed at $16-60 per ton. *Soapstone* remains firm at $15-25 per ton.

Chicago, December 12, 1919.

Of outstanding interest in all lines of industry and commerce at the present moment, at least in the Middle West, is the effect of the existing fuel shortage. The chemical industry, as far as production is concerned, is touched to a relatively slight degree. Fuel administrators have ruled that where interruption of a continuous process would result in damage to plant or goods in process, no shut-down is necessary. Chemical processes which generate their own heat are likewise permitted to run, and only those which fall out of these two classes are required to conform to the three-days-a-week ruling.

This is also true in the metallurgical field, so that refiners and smelters are affected only so far as their receipts of ores are cut by the reduction of working time at the mines. Distribution is being affected to a certain extent, many users of chemical products being forced to suspend or operate on part time. The great fertilizer plants in the Chicago district are entirely shut down, but, as no deliveries are being made at this season of the year, the effect of this is almost nil. There is apparently no possibility of the cessation of production lasting long enough to cause any shortage next year.

HEAVY CHEMICALS:—All prices are holding firm, with demand normal. A sudden unexplained shortage has developed in sodium bichromate, which, following its fluctuation between 13c. and 15c. in the last five months, has suddenly shot up to where 32c. would probably be a fair quotation today. Some offerings have been made at 40c., but none has changed hands at that figure. Ammonium chloride (white salammoniac) is also very scarce and has increased from 13c. a month ago to from 15c. to 16c.

Solid caustic soda is being sold heavily on export orders and the price is now up to about $4.00 cwt. f.o.b. works. The granulated is bringing about the same figure. Aside from the above mentioned items, the heavy chemical list shows no changes from quotations of recent date.

COAL-TAR PRODUCTS: — Although no changes in quoted prices are seen, a decided stiffening of the market can be felt, due to scarcity of crudes. Spot stocks are very low and producers report output sold, in some cases, ninety days ahead. Continued difficulties with coal supply may lead to serious shortage. As previously noted, current prices are: On benzol, 25c.; toluol, 26c.; aniline oil, 32c. to 33c.; aniline salts, 36c.; salicylic acid, 45c.; benzoic acid, 95c.

VEGETABLE OILS:—Uncertain demand produced a spotty market in vegetable oils here recently. Cotton oil is firm, with crude quoted at 1c. advance, at 18c., and prime summer yellow in barrels at 25c. Demand seems to be slightly in excess of supply. Corn oil is fairly active, still being quoted at 18c. in sellers' tanks. Linseed took a big jump and is over $2 in less than 5-bbl. lots, $2.09 being asked. In larger quantities the price is around $2.04.

Cocoanut oil fluctuates between 17½c. and 18½c. for miller grade, with the general trend being toward the higher price, but with demand a little bit weak. Soya bean oil also showed strength, as sales were made at 17½c. in barrels, f.o.b. Chicago, with Pacific coast quotations ruling at 16½c. in sellers' tanks. The high price of silver in exchange with the Far Eastern countries will tend to strengthen greatly both copra and soya oils.

FLOTATION OILS—NAVAL STORES:—The upward trend of pine products, which was interrupted early in the fall, has, under pressure of export sales and exhaustion of stocks of small dealers, resumed its course, as had been anticipated. Turpentine heads the list with a quotation of from $1.95 to $1.98, and not much is available even at such figures. Pine tar oil is also higher, .933 pure steam distilled now bringing $1.60 to $1.65. Some industries requiring destructively distilled, and that commodity being so short as to be practically off the market, the usual differential between it and the pure has been wiped out, and it is now also quoted at $1.60 to $1.65. Rosin has held quiet since the last quotation, F grade still being obtainable at $19 and W. W. at $24.50.

NOTE: Owing to an error in proofreading, the price list printed in our last issue was dated Nov. 30 instead of Dec. 6.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, NOV. 30, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.60 – $0.65
Acetone	lb.	$0.20 –	.21 –
Acid, acetic, 28 per cent	cwt.	2.50 – $2.75	3.00 – 3.25
Acetic, 56 per cent	cwt.	5.00 – 5.50	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.50 – 13.50	13.50 – 15.50
Boric, crystals	lb.	.13 – .13½	.13½ – .14½
Boric, powder	lb.	.13 – .13½	.13½ – .14½
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	1.50 – 1.75	2.00 – 2.50
Hydrofluoric, 52 deg.	lb.	.12 –	.14 –
Lactic, 44 per cent. tech	lb.	.11 – .14	.12 – .16
Lactic, 22 per cent. tech	lb.	.05 – .06	.05½ – .07
Molybdic, C. P.	lb.	–	4.00 – 4.25
Nitric, 40 deg.	lb.	.06 – .06½	.07 – .08½
Nitric, 42 deg.	lb.	.07 – .07½	.08 –
Oxalic, crystals	lb.	.23 – .25	.25 – .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 –	.10 – .14
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	–	2.30 – 2.60
Sulphuric, 60 deg., tank cars	ton	12.00 – 16.00	–
Sulphuric, 60 deg., drums	ton	17.00 –	22.00 –
Sulphuric, 60 deg., carboys	ton	20.00 –	29.00 –
Sulphuric, 66 deg., tank cars	ton	17.00 – 18.00	22.00 – 23.00
Sulphuric, 66 deg., drums	ton	20.00 – 21.00	25.00 – 26.00
Sulphuric, 66 deg., carboys	ton	25.00 –	30.00 – 40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 –	26.00 –
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 –	32.00 –
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 –	35.00 –
Tannic, U. S. P.	lb.	–	1.35 – 1.45
Tannic (tech.)	lb.	–	.42 – .55
Tartaric, crystals	lb.	–	.73 – .74
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl	gal.	4.80 – 4.95	5.50 –
Alcohol, Methyl	gal.	1.30 –	1.33 – 1.38
Alcohol, denatured, 188 proof	gal.	.66 –	.68 – .70
Alcohol, denatured, 190 proof	gal.	.62 –	.64 – .66
Alum, ammonia lump	lb.	.03½ – .04½	.04½ – .04½
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03½ – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08 –	.08½ – .09
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	–	.30 – .35
Ammonium carbonate, powder	lb.	.13 – .13½	.14 – .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½ – .13	.13½ – .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 – .12½	.13 – .13½
Ammonium nitrate	lb.	.10 –	.11 – .12
Ammonium sulphate	lb.	.05 –	.06 –
Amyl acetate	gal.	–	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	–	.09 – .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	–	–
Barium chloride	ton	85.00 –	90.00 – 100.00
Barium dioxide (peroxide)	lb.	.22 –	.24 –
Barium nitrate	lb.	.09½ – .10½	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.03½ – .04
Bleaching powder (see calcium hypochlorite)		–	–
Blue Vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	–	.65 – .75
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	–	.04½ – .05
Calcium chloride, fused, lump	ton	19.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01½	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	–	2.75 – 3.75
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 –
Calcium sulphate, precipitated	lb.	–	.09 – .09½
Carbon bisulphide	lb.	.05½ –	.06 –
Carbon tetrachloride, drums	lb.	.10 – .11	.12 – .14
Carbonyl chloride (phosgene)	lb.	–	.75 –
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.08 –
Cobalt oxide	lb.	–	1.50 – 1.55
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	–	.28 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .08½	.09 – .09½
Cream of tartar (see potassium bitartrate)			–
Epsom salt (see magnesium sulphate)		–	–
Formaldehyde, 40 per cent	lb.	–	.32 – .37
Glauber's salt (see sodium sulphate)		–	–
Glycerine	lb.	–	.24½ – .26
Iodine, resublimed	lb.	–	4.50 –
Iron oxide, red	lb.	–	.03 – .20
Iron sulphate, (copperas)	cwt.	1.00 –	1.20 – 1.50
Lead acetate, normal	lb.		.12½ – .14½
Lead arsenate (paste)	lb.	–	.13 – .17
Lead nitrate, crystals	lb.	–	.85 – .86½
Litharge	lb.	–	.09½ – .10½
Lithium Carbonate	lb.	–	.50 –
Magnesium carbonate, technical	lb.	–	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	2.00 – 2.63	2.75 – 3.00
Magnesium sulphate, commercial	100 lb.	1.75 –	2.00 – 2.50
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.12 –	.15 – .16
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	–	.75 – .90
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.26 – .27	.30 – .33
Potassium bitartrate (cream of Tartar)	lb.	–	.55 – .60
Potassium bromide, granular	lb.	–	.50 – .65
Potassium carbonate, U. S. P.	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.25 –	.26 –
Potassium chlorate, crystals	lb.	.17 – .20	.21 – ...
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.30 – .32	.35 – .40
Potassium iodide	lb.	–	3.55 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	–	.55 – .65
Potassium prussiate, red	lb.	–	1.05 – 1.15
Potassium prussiate, yellow	lb.	–	$0.45 – $0.55
Potassium sulphate	ton	225.00 –	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake (sodium sulphate)	ton	17.00 – 21.00	–
Silver cyanide	oz.	–	1.19 –
Silver nitrate	oz.	–	.76½ – ....
Soda ash, light	100 lb.	2.00 –	2.05 – ....
Soda ash, dense	100 lb.	2.25 – 2.35	2.50 – 2.75
Sodium acetate	lb.	.05½ – .06½	.07 – .08
Sodium bicarbonate	100 lb.	2.60 –	2.75 – 3.00
Sodium bichromate	lb.	–	.38 – .42
Sodium bisulphate (nitre cake)	ton	3.00 – 8.00	10.00 –
Sodium bisulphite	cwt.	1.80 – 1.90	2.00 – 2.10
Sodium borate (borax)	lb.	.08 – .09	.08½ – .09
Sodium carbonate (sal soda)	100 lb.	1.35 – 1.50	1.50 – 1.75
Sodium chlorate	lb.	.15 –	.16 – .18½
Sodium cyanide, 96-98 per cent	lb.	.30 –	.31 – .34
Sodium fluoride	lb.	.14 –	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	–	– 3.80
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	– 3.25	3.75 – 4.00
Sodium nitrite	lb.	.15 – .17	... – .18
Sodium peroxide, powdered	lb.	–	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.43 – .45½
Sodium prussiate, yellow	lb.	.24½ – .26	.27½ – .28
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.03½ – .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.15 – 1.25	1.50 – 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	–	.05 – .06
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.25 –	.28 –
Sulphur chloride	lb.	.05½ –	.06 –
Sulphur, crude	ton	22.00 –	–
Sulphur dioxide, liquid, cylinders	lb.	–	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.10 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 –	3.15 – 3.40
Tin bichloride (stannous)	lb.	.44 –	.46 – .50
Tin oxide	lb.	–	.60 –
Zinc carbonate, precipitate	lb.	–	.20 –
Zinc chloride, gran.	lb.	.12½ –	.13½ – .14
Zinc cyanide	lb.	.49 –	.50 –
Zinc dust	lb.	.09 – .11	.11 – .14
Zinc oxide, dry American	lb.	–	.09½ – .12
Zinc sulphate	lb.	.03½ – .03½	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.32	—	.50
Aniline oil, drums extra	lb.	.34	—	.35
Aniline salts	lb.	.37	—	.....
Anthracine, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.00	—	1.15
Benzidine, base	lb.	1.75	—	.....
Benzidine, sulphate	lb.	.90	—	1.15
Benzoic acid, U. S. P.	lb.	.90	—	1.10
Benzoate of soda, U. S. P.	lb.	.80	—	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27	—	.31
Benzol, 90%, in drums (100 lb.)	gal.	.25	—	.29
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	3.75	—	4.50
Beta naphthol, sublimed	lb.	.75	—	.80
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.80	—	.85
Cresylic acid, 95-97%, dark, in drums	gal.	.85	—	.90
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.40	—	2.25
Dimethylaniline	lb.	.80	—	.85
Dinitrobenzol	lb.	.26	—	.37
Dinitroclorbenzol	lb.	.25	—	.30
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.32	—	.36
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.65
Diphenylamine	lb.	.58	—	.75
H-acid	lb.	1.60	—	1.75
Metaphenylenediamine	lb.	1.15	—	1.80
Monochlorbenzol	lb.	.12	—	.15
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.06½	—	.07½
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	.75	—	1.25
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.40	—	.45
Nitro-toluol	lb.	.27	—	.20
Ortho-amidophenol	lb.	3.00	—	4.25
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.90	—	1.25
Ortho-nitro-toluol	lb.	.25	—	.40
Ortho-toluidine	lb.	.25	—	.45
Para-amidophenol, base	lb.	2.50	—	3.50
Para-amidophenol, HCl	lb.	2.50	—	3.25
Para-dichlor-benzol	lb.	.15	—	.18
Paranitraniline	lb.	.95	—	1.10
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.50	—	4.00
Paratoluidine	lb.	1.75	—	2.50
Phthalic anhydride	lb.	1.50	—	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12½	—	.16
Pyridin	gal.	2.00	—	2.50
Resorcin, technical	lb.	3.75	—	4.00
Resorcin, pure	lb.	6.50	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45	—	.60
Salicylic acid, U. S. P.	lb.	.45	—	.50
Salol	lb.	.90	—	.95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.22	—	.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30

Tolidine	lb.	$1.70	$2.50
Toluidine, mixed	lb.	.45	.55
Toluol, in tank cars	gal.	28	.....
Toluol, in drums	gal.	.32	.30
Xylidine, drums, 100 gal.	lb.	.44	.50
Xylol, pure, in drums	gal.	.37	.45
Xylol, pure, in tank cars	gal.	.35	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	.45
Xylol, commercial, in tank cars	gal.	.23	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.42	$0 44
Beeswax, refined, yellow	lb.	47	.48
Beeswax, white pure	lb.	.64	.66
Carnauba, No. 1	lb.	.85	.87
Carnauba, No. 2, regular	lb.	.65	.78
Carnauba, No. 3, North Country	lb.	.48	.50
Japan	lb.	.18½	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	....	...
Paraffine waxes, crude, scale 124-126 m.p.	lb.	....	.06½
Paraffine waxes, refined, 118-120 m.p	lb.	....	.09
Paraffine waxes, refined, 128-130 m.p	lb	....	.10½
Paraffine waxes, refined, 133-135 m.p.	lb.	....	.12
Paraffine waxes, refined, 135-137 m.p	lb.	....	.13
Stearic acid, single pressed	lb.	.23	.26
Stearic acid, double pressed	lb.	.28	.29
Stearic acid, triple pressed	lb.	.32	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.25
Pine oil, pure, dest. dist	gal.	1.00
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.47
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.00
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	....
Pinewood creosote, ref.	gal.	.51

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$17.00	$17.50
Rosin E-I	280 lb.	17.55	18.25
Rosin K-N	280 lb.	19.75	23.00
Rosin W. G.-W. W	280 lb.	22.50	24.25
Wood rosin, bbl	280 lb.	17.00	17.50
Spirits of turpentine	gal.	1.65	1.66
Wood turpentine, steam dist	gal.	1.63	....
Wood turpentine, dest. dist	gal.	1.50	....
Pine tar pitch, bbl	200 lb.	8.25	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	14.90
Retort tar, bbl	280 lb.	15.00	15.25
Rosin oil, first run	gal.	.86	.91
Rosin oil, second run	gal.	.88	.93
Rosin oil, third run	gal.	.95	1.12
Rosin oil, fourth run	gal.	1.05	1.15

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.53	$0.54
Upriver coarse	lb.	....	.35½
Upriver caucho ball	lb.	.34½	.35½
Plantation—First latex crepe	lb.	.51½	....
Ribbed smoked sheets	lb.	.51½	....
Brown crepe, thin, clean	lb.	.46½	.47½
Amber crepe No. 1	lb.	.49	....

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.18½	$0.19
Castor oil, AA, in bbls	lb.	.21½	.22
China wood oil, in bbls	lb.	.22½	.23
Cocoanut oil, Ceylon grade, in bbls	lb.	.17½	.18½
Cocoanut oil, Cochin grade, in bbls	lb.	.19½	.20
Corn oil, crude, in bbls	lb.	....	.21½
Cottonseed oil, crude (f.o.b. mill)	lb.	.18	.19
Cottonseed oil, summer yellow	lb.	....	.27
Cottonseed oil, winter yellow	lb.	....	.28
Linseed oil, raw, car lots	gal.	....	1.87
Linseed oil, raw, tank cars	gal.	....	1.83
Linseed oil, boiled, car lots	gal.	....	1.90
Olive oil, commercial	gal.	2.50	2.80
Palm, Lagos	lb.	.17	.17½
Palm, bright red	lb.	.16½	.17½
Palm, Niger	lb.	.16	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.23½	.23½
Peanut oil, refined, in bbls	lb.	.27	.28
Rapeseed oil, refined in bbls	gal.	1.45	1.50
Rapeseed oil, blown, in bbls	gal.	1.60	....
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.17½	.18½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½	.15½

FISH

Winter pressed Menhaden	gal.	$1.20	.....
Yellow bleached Menhaden	gal.	1.23	....
White bleached Menhaden	gal.	1.25	.....
Blown Menhaden	gal.	1.26	....

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	$40.00
Barytes, off color	ton	20.00	25.00
Blanc fixe, dry	lb.	.03½	.04½
Blanc fixe, pulp	ton	30.00	50.00
Casein	lb.	.16	.18
Chalk, English, light	lb.	.05	.07
Chalk, English, light	lb	.04½	.06
Chalk, English, dense	lb.	$ .04	$ .05
China clay (Kaolin), imported, lump	ton	25.00	35.00
China clay (Kaolin), imported, powdered	ton	30.00	60.00
China clay (Kaolin), domestic, lump	ton	10.00	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	40.00
Feldspar	ton	13.50	17.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	30.00	35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	45.00
Fuller's earth, domestic, powdered	ton	25.00	30.00
Fuller's earth, imported, powdered	ton	35.00	40.00
Pumice stone, imported	lb.	.03	.06
Pumice stone, domestic	lb.	.02½	.....
Shellac, TN	lb.	1.10	1.15
Shellac, D. C.	lb.	.....	....
Shellac, V. S. O.	lb.	.....	....
Shellac, Diamond I.	lb.	.....	....
Shellac, orange, fine	lb.	1.25	.....
Shellac, orange, superfine	lb.	1.20	1.30
Shellac, A.C. garnet	lb.	1.10	.....
Shellac, bleached, bone dry	lb.	1.35	.....
Shellac, bleached, fresh ground	lb.	1.10	1.15
Soapstone	ton	15.00	25.00
Talc, domestic	ton	16.00	60.00
Talc, imported	ton	60.00	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	1,000	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.25	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70	.....
Ferro-manganese, 70-80% Mn	gross ton	110.00	115.00
Spiegeleisen, 16-20% Mn	gross ton	33.00	36.00
Ferro-molydenum, per lb. of Mo	lb.	3.00	3.50
Ferro-silicon, 50%	gross ton	85.00	95.00
Ferro-silicon, 75%	gross ton	150.00	175.00
Ferro-silicon, 10-15%	gross ton	45.00	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	1.40
Ferro-uranium, 35-50%, of U.	lb.	7.00	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, $C_2.O_3$	unit	$0.60	$0.80
Chrome ore, 48% and over	unit	1.00	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	7.50
*Coke, furnace, f.o.b. ovens	net ton	6.00	6.50
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	12.50
Fluorspar, gravel, f.o.b. mines	net ton	.....	25.00
Manganese ore, 45% Mn and over	unit	.50	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	10.00
Uranium oxide, 96%	lb.	2.75	3.00
Vanadium pentoxide, 99%	lb.	6.00	.....
Pyrites, foreign, lump	unit	.17	.....
Pyrites, foreign, fine	unit	.17	.....
Pyrites, domestic, fine	unit	.16	.17½
Ilmenite, 52% TiO_2	lb.	.02	.....
Rutile, 95% TiO_2	lb.	.11	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	3.00
Zircon, washed, iron free	lb.	.10	.....
Monazite, per unit of ThO_2	unit	42.00	.....

* Government prices.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.80
Lump lime, common, including container 300	bbl.	2.65
Common brick, at dock	M.	16.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	50.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	40.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	1.75
Linseed oil, 5 gal. cans	gal.	1.90
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

NOTE—These items were compiled as of Dec. 12, but appear in this issue due to the delay in publication due to the printers' strike.

Connecticut

HARTFORD—The East Hartford District is having preliminary plans prepared for the construction of a 2-story, 62 x 124-ft. school with a 42 x 57-ft. ell. A chemical laboratory will be installed in same. Estimated cost, $200,000. Johnson & Burns, 174 Bond St., architects.

HARTFORD—The Hartford Fairmont Co., 41 Arch St., will soon award the contract for the construction of an addition to its glass manufacturing plant on Arch St. Estimated cost, $65,000. Ford, Buck & Sheldon, Inc., 60 Prospect St., engineer.

Illinois

CHICAGO — The Armour Fertilizer Works, Union Stock Yards, has awarded the contract for the construction of an acid plant to Westinghouse, Church, Kerr, Inc., 37 Wall St., New York City. Estimated cost, $150,000.

EAST ST. LOUIS—The St. Louis Pressed Steel Co., Merchants Exchange Bldg., has purchased a site at 26th and Bond Sts. and plans to build a steel mill. Estimated cost, $40,000. Fred Key, manager.

WEST FRANKFORT—The Board of Education will receive bids about Feb. 10 for the construction of a 2-story, 94 x 215-ft. school. A small laboratory will be installed in same. Estimated cost, $200,000.

Indiana

AETNA—The Aetna Iron & Steel Co., Gary, has awarded the contract for the construction of 1-story, 225 x 600-ft. and 75 x 400-ft. rolling mills here, to the Northwestern Bridge & Iron Co., 132nd and Hopkins St., Milwaukee, Wis. Estimated cost, $350,000.

HUNTINGBURG—The city is having plans prepared for the construction of a sewerage system and a disposal plant. Estimated cost, $75,000. C. Brossman, Merchants' Bank Bldg., Indianapolis, engineer.

Iowa

DES MOINES—A. Clemens, chairman of the Building Committee, care of Granette Products Co., 725 2nd St., has awarded the contract for the construction of a 80 x 120-ft. factory, for the manufacture of ornamental concrete products, at 9th and Murphy Sts., to J. E. Lovejoy, 1006 Mulberry St. Estimated cost, $30,000.

Kentucky

BOWLING GREEN—The Atlantic Producing & Refining Co. has purchased and will develop oil properties, also build additions to a plant for refining petroleum and manufacturing lubricating oil and wax. Estimated cost, $300,000. W. G. Williams, president.

Massachusetts

CAMBRIDGE—The G. H. Dyer Co., (welder) 155 Brookline St., has awarded the contract for the construction of a 2-story, 55 x 100-ft. factory and a 1-story, 30 x 40-ft. boiler house on Brookline St., to F. J. Van Etten Co., 153 Milk St., Boston. Estimated cost, $30,000.

EAST BOSTON (Boston P. O.)—I. Young & Co., 85 Border St., has awarded the contract for the construction of a 2-story, 74 x 80-ft. coppersmith factory on Border St., to Patrick Rich, 67 Byron St. Estimated cost, $28,000. Noted Oct. 22.

HOLYOKE—The Valley Paper Co., 2nd Level Canal, has awarded the contract for the construction of a 2-story, 50 x 350-ft. factory, to P. J. Kennedy & Co., 464 Maple St. Estimated cost, $70,000.

MEDFORD—The American Radio & Research Corporation, Medford Hillside, will soon receive bids for the construction of a 1 and 2-story, 140 x 200-ft. factory. Estimated cost, $90,000. H. F. Bryant, 334 Washington St., Brookline, engineer.

WATERTOWN—The Hood Rubber Co., Nichols Ave., has awarded the contract for the construction of two additions to its factory on Nichols Ave., one 3-story, 32 x 96-ft. and one 1 or 2 story, 60 x 220-ft. to the Aberthaw Construction Co., 27 School St., Boston. Estimated cost, $80,000.

WOBURN—The Buckman Tanning Co. is receiving bids for the construction of a sewage disposal plant. Estimated cost, $20,000. Vaughan & Meyer, Security Bldg., Milwaukee, engineers. Noted Oct. 29 and Nov. 5.

Michigan

BAY CITY—The Columbia Sugar Co., 508 Crapo Block, plans to construct a 1 to 3-story, 800 to 1000-ton capacity factory. A. H. Smith engineer.

Minnesota

MINNEAPOLIS — The Northwestern Glass Co., 219 Second St., N., plans to construct a 4-story, 66 x 162-ft. factory addition on 2nd Ave., and North 2nd St. Estimated cost, $100,000. Bertrand & Chamberlain, Northwestern Bank Bldg., architects.

Missouri

ST. LOUIS—The Sugar Products Co., 16 Exchange Pl., New York City, has awarded the contract for the construction of a 500,000-gal. molasses storage factory on Tesson & Van Buren Sts., to Murch Brothers Construction Co., Railway Exchange Bldg. Estimated cost, $125,000.

New York

FREYDENBURGH FALLS—The Farmers Standard Carbide Co. has retained W. E. Moore & Co., engineers, Union Bank Bldg., Pittsburgh, Pa., to prepare plans for the construction of a new carbide plant. The plant will be equipped with a Moore 3-phase carbide furnace, with a 30-ton per day capacity. The 46-ft. water fall will be developed for a capacity of 3700 hp. Crushing, screening and can-making machinery will be installed in same.

GENEVA—The Geneva Glass Products, Inc., plans to install glass-making and glass-handling equipment. Estimated cost between $15,000 and $20,000. Address R. S. Ellinwood, manager.

LONG ISLAND CITY—Dings & Schuster, 510 West 25th St., New York City, have awarded the contract for the construction of a 2-story, 56 x 84-ft. oil factory on 14th St., near Van Alst St., to the Aljou Construction Co., Inc., 51 East 42nd St., New York City. Estimated cost, $40,000.

LONG ISLAND CITY—The Pathe Exchange, Inc., 25 West 45th St., New York City, is having plans prepared for the construction of a laboratory and studio. Estimated cost, $700,000. Stone & Webster, 120 Broadway, New York City, architects and engineers. Noted Oct. 29.

THIELLS—L. F. Pilcher, State Architect, Capitol, Albany, has awarded the contract for furnishing chlorinating apparatus for the proposed addition to the sewage disposal plant at Letchworth Village, to the Suburban Engineering Co., 15 West 38th St., New York City.

Ohio

ASHTABULA—L. A. Amsden, city engineer, is preparing plans and will submit estimates for the construction of a sewage disposal system.

CAREY—The Carey Tire & Rubber Co. has awarded the contract for the construction of a 3-story, 80 x 160-ft. rubber factory, to C. N. Dennis, Tiffin. Estimated cost, $150,000.

CLEVELAND—The Glidden Varnish Co., West 110th St. and Berea Rd., has awarded the contract for the construction of a 3-story, 60 x 100-ft. factory on Berea Rd., to the Hunkin-Conkey Co., Century Bldg. Estimated cost, $600,000.

GREENVILLE—The city plans to construct a filtration plant. Estimated cost, $135,000. G. A. Johnson Co., 150 Nassau St., New York City, engineer.

Oregon

RICHLAND—The Town Council will soon award the contract for the construction of a waterworks system, including four miles of 8-in. supply main, steel or iron pipe, 50 water meters, connections, a 125,000-gal. per minute filtration plant, one mile of distributing system, etc. Estimated cost, $35,000. L. C. Kelsey, 410 Selling Bldg., Portland, engineer.

VALE—The Idaho Mutual Sugar Co. has purchased 4000 acres of land for beet growing and plans to build a 2 or 3-story, 500-ton daily capacity sugar factory on Dead Ox Flat. Estimated cost, $1,000,000.

Virginia

ORANGE—The city will soon award the contract for the construction of cast iron water mains from the town to the Rapidan River; also for the installation of a filtration plant and pumping station. Address A. J. Harlow, mayor. Sayville & Claiborne, 7th and Main Sts., Richmond, engineers. Noted Oct. 29.

West Virginia

PARKERSBURG—The Vitrolite Co. has awarded the contract for the construction of a 1-story, 200 x300-ft. factory addition, to Plote & Vogle, Parkersburg. Estimated cost, $300,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a meeting in St. Louis from Dec. 26 to Jan. 1.

THE AMERICAN CERAMIC SOCIETY will hold its annual meeting in Philadelphia, Pa., Feb. 23-26.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive, in St. Louis.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9, and 10.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York, Feb. 16-19.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting in St. Louis from Dec. 26 to Jan. 1.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15.

THE MINING AND METALLURGICAL SOCIETY OF AMERICA will hold a meeting in New York Jan. 13.

Industrial Notes

MUNN & Co., patent attorneys, Washington, D. C., Chicago and New York, announce that Mr. L. A. Paley has entered their office as one of their attorneys.

HAMILTON & HANSELL, INC., 13 Park Row, New York City, will from now on dedicate its entire business to metallurgical and general engineering work. In conjunction with domestic work, it will carry on development of foreign patents and enterprises. A separate company, namely, the American Transmarine Co., has taken over all the general export and import business not relating to engineering. For the past 5 years Hamilton & Hansell, Inc., has been licensee and builder of the American Rennerfelt electric furnace for ferrous and nonferrous work, and has also designed a number of electric reduction and electrochemical plants. The following contracts were closed during the last three months: One 1000-lb. 200-k.v.a. Rennerfelt furnace, for special iron, A. M. Byers Co., Pittsburgh, Pa.; one 200-k.v.a. Rennerfelt special furnace, for glazing fused silica, General Ceramics Co., Perth Amboy, N. J.; one 4-gross-ton, 1200-k.v.a. Rennerfelt furnace for tool steel, for export to Sweden; one 300-lb. 100-k.v.a. Rennerfelt furnace for aluminum alloys, Hauch Machine Tool Co., Springfield, Mass.; two 1000-lb. 200-k.v.a. Rennerfelt furnaces, for high speed steel (cast tools). U. S. High Speed Steel & Tool Corporation, Albany, N. Y.

Published December 24th, With Current News

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
WALLACE SAVAGE
Assistant Editor

CHEMICAL
& METALLURGICAL
ENGINEERING
A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

ALAN G. WIKOFF
Assistant Editor
L. W. CHAPMAN
Western Editor
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, December 10-17, 1919 *Number* 14

Out of The Woods

AS NOTED in our 11th issue, published December 8, but dated October 29-November 5, the problem before us at that time was to "catch up," and the best way out into the open then apparent was indicated. Since that date there have been printed, including the present issue, three double numbers in slightly more than two weeks, so that the present issue is mailed on the regular publication date. However, there still exists one issue not printed, which will be consolidated with the last number of the year, mailed one week hence. Thus it is that starting in with the New Year, CHEMICAL & METALLURGICAL ENGINEERING will be square with the world, and can buckle down to the long road ahead, to its function as a weekly technical journal advocating the best possible engineering practice in applied chemistry.

Every Engineer A Counter Propagandist

THE philosophic GOETHE lived in days when Germany was poor in pocket, but great in mind. And when, in "Faust," he desired to represent in *Mephistopheles* the spirit of evil, he made him the spirit that denied all things. He took the ecclesiastical devil and made him a devil of everyday life; for the spirit of evil of our day and generation is that which denies. Let us consider the subject for a minute or so.

The real trouble with labor just now is that in following KARL MARX it has come to the conclusion that labor is the true and sole source of all wealth, and that the representatives of capital are, in effect, the receivers of stolen goods; that they have got control of the machinery of laws and justice, and that the only way for labor to come into its own is to strike, and strike, until the administrators of capital are driven to cover, leaving capital behind them. Then labor will take this and enjoy its fruits. It may not sound reasonable, but such is the gospel.

Now if, in working for a man, a laborer believes his employer to be, in effect, a receiver of stolen goods, and therefore in criminal possession of his property, he cannot have faith in such a man, nor will he want to see him prosper. As a worker he will do as little as possible. If he belongs to the I. W. W., or is a Communist, or a Socialist of the radical wing, these are likely to be the views he holds. And the propaganda of these organizations, which he gets and the rest of us do not, teaches that government and courts are based upon an organization of capital; that they are founded on false premises, and should therefore be overthrown. The plan is to supplant the government by a "proletariat dictatorship" until a government of and by workers is established.

This is the doctrine that foments strikes, and resents profit-sharing, or any kind of internal organization of workers. The control of workers, it is held, should be from the outside, so as to destroy the minions of capital who are in control of industry.

Among many agitators this doctrine has become an *idée fixe*, and they can no more be argued out of it than a gamecock can be reasoned into leading a life of amity with his Plymouth Rock brethren in a barnyard. They don't want to be argued out of it, and they have a string of verbiage in reply to argument that would confuse a Philadelphia lawyer. Their business is rebellion; rebellion is their normal state, and if there were to be brought about the general strike which they are always trying to initiate, or the rebellion of the proletariat which they constantly urge should ensue, they would be quick to arise in opposition to it. They have no sense of system or of order, and whoever establishes system or order becomes their enemy thereby. This they constantly prove, even while denying it. Their policy is destructive, but never constructive. They hold the Russian Soviets to be a glorious success, and declare that those of us who do not agree with them have been misled by the false reports of a capitalistic press.

Not all our workingmen are built that way. Many are ambitious, and want to gain property for themselves; they want to own property, in time, and to be protected in their ownership. But we are neglecting our opportunity if we do not reason with them, and strive to keep their minds open while the apostles of anarchy are seeking with every persuasion at their command to close them. We must go out and do this thing ourselves, and we must put heart into this self-imposed task because men in revolt will not listen to paid pacifiers. We cannot trick them into assent, either, because trickery, like murder, will out. Then it breeds dissent. To accomplish this is difficult, and often disheartening, but it is the only way out. Industry requires eager and enthusiastic labor rather than cheap hands, and unless those of us engaged in industry become teachers of good citizenship by example as well as by precept, our industries are doomed. Neither invention nor astuteness can meet the deadening influence of denial and hate which thousands of agitators are preaching in nearly every industrial center, and which, if they succeed, will bring about such a reign of terror and confusion as to kill freedom—freedom for the individual man and woman. Not only will it put an end to legitimate personal opportunity, but it will utterly destroy free government.

Oil Shales and The Merchant Marine

THE United States Shipping Board now has control of a merchant marine of about 11,000,000 net tons —next to England's the largest in the world. This is the nucleus of a fleet of American-made and American-operated ships that may well re-establish our easily lost supremacy of the seas. Advent of coal-burning steamships, combined with England's vision in establishing coaling stations under the British flag throughout the world, was a potent cause of our downfall; the advent of oil-burning steamships and the vision of our Government in establishing fuel-oil stations throughout the world under the American flag will at least enable us to maintain our present maritime position. Coaling stations can be no more than 4000 miles apart, that distance being about the steaming radius for coal-burning ships, but an oil-burning vessel can steam 10,000 miles without refueling—and our established stations are within that distance apart. St. Thomas and the Azores in the Atlantic, Bizerta in the Mediterranean, the Philippines and Hawaii in the Pacific and Colon on the Isthmus assume added importance in this aspect of the situation.

If fully taken advantage of, the operation of an American Merchant Marine will be of incalculable value to the nation and should assure for our exports a freedom from foreign interference. All this provided the source of the fuel oil as well as the fueling stations be under the control of our Government to the extent of being located on American soil. Obviously, in time of danger it would be necessary for us to control absolutely the productive areas as well as the storage supplies and points of distribution.

The problem of supplying these fueling stations in the future is of considerable concern to those who are in position to understand the consequences should a serious shortage develop. Our petroleum fields have a limited length of life; it seems to be the consensus of opinion on the part of oil geologists that the probability of discovering further large oil fields within the boundaries of the United States is remote. We cannot be dependent upon oil from fields that are under the control of other nations in time of war, and for economic reasons it is not desirable in times of peace. By a process of elimination one arrives at the eventual resources of the nation—liquid fuel from solid carbonaceous material—peat, lignite, coal, bituminous sandstones and oil shales.

The Navy Department with commendable vision has had large tracts of oil-shale lands withdrawn from entry in order to establish a reserve for the future, and with this end in view is co-operating with the Bureau of Mines in the development of methods whereby the oil in this shale can be made available for use. The Southern Pacific Railway Company is also co-operating with the Bureau of Mines along these same lines, realizing the importance of a source of fuel-oil supply along its right-of-way independent of the California petroleum fields. It would also seem desirable that the Shipping Board investigate the feasibility of developing a supply of fuel from oil shales.

It will be necessary to conduct extensive and costly experiments before the technical problems connected with the distillation of oil from shale and the recovery of the by-products will be economically solved. It is certain that a profitable shale-oil development will require large capital expenditures, and successful installations must be able to handle large tonnages from deposits that are known to be of sufficient magnitude to assure a long life to the enterprise. Potentially the oil-shale deposits in our Western States are a national asset of first importance, but their development should proceed along rational lines and should be undertaken only by those thoroughly cognizant of the financial and technical magnitude of the problems involved in the establishment of an oil-shale industry. Wildcatters are ready, but enormous monetary loss can be avoided by some scientific agency approaching the problem with the wide technical view necessary for success.

Reconstruction Still Lags

IN A material way the greatest loss occasioned by the prosecution of the war was the curtailment in construction work. In normal times the world is continually building highways, railroads, factories, hotel and office structures, dwelling houses, power plants, and such things. The war greatly curtailed this activity, and thus there was a great halt in progress. Undoubtedly, taking the world as a whole, that loss was a greater amount than the loss by direct destruction.

During the year following the Armistice, however, such work has not only not been prosecuted with greater than normal vigor, but there has not been even the normal amount of such activity. The war, in other words, continues to retard progress. This loss has been world wide. It is not confined to the belligerent countries. Sir GEORGE PAISH was right when, in February, 1916, in an article in the New York *Sun*, he said: "The idea that the United States is deriving any advantage whatever from the war is a complete delusion. All that is happening to the advantage of your country is that it is suffering less than the belligerents as a result of this titanic conflict."

He was right. What appeared to be a gain during the period before the United States entered the war was simply that the other countries were losing more than we, and thus we came to occupy a better position, simply relative to them. For instance, we made shells for Great Britain, for which that country now owes us money, and eventually it will pay us interest at a low rate. If instead of making shells we had drained swamp lands or built hydro-electric plants, we would now have the improvements and they would be paying us much larger dividends than the interest from Great Britain will amount to when it is paid, for just now we are not even getting paid hard money for interest, we are actually engaged in funding the interest. When the United States entered the war the case was made so much the stronger.

It is true that the war added much to the knowledge of the world. It developed aviation, for instance, and gave the chemical industries, particularly in the United States, a great deal of information that they did not have prior to the war. Knowledge, however, is useless if not applied, and to apply most of the knowledge contributed by the war, construction is necessary. Construction is retarded by effects of the war, high prices, unwillingness of men to work hard, but possibly more than any other one thing, to the growing spirit of distrust and lack of confidence which is arming each man even against his friend and neighbor. Yet there are some bright sides to the situation.

Industry must stagnate when it has no improvements to make, when manufacturers have no ideas whereby they could embark in fresh ventures. There is an ample store of ideas. It is dangerous for too much construction work to be indulged in. A favorite theory as to industrial depressions is that they are caused by there having been too much construction work, too much capital having been converted from liquid to fixed form. Present conditions, as to costs and the unwillingness of men to work hard and efficiently, tend to discourage construction work, and while some is being done, enough to furnish all the work that men are willing to do, there is a great deal of work that is held in abeyance. This can be done in the future when men are willing to do it. One cannot possibly see at the present time any danger that construction work will be carried too far. In eight years after the Civil War we doubled our railroad mileage, building 35,000 miles, and then found we had built more railroad than we could patronize to a sufficient extent to make it pay well. Now we are not building railroad at all and are building scarcely any rolling stock.

We are, however, building tremendous numbers of automobiles and we must be making enormous numbers of silk shirts, judging by the stories in circulation as to the way workmen are buying them. This is not the conversion of liquid capital into fixed capital, to produce in some later year an industrial depression. It is converting money into something that is very far from being fixed. By many all of this extravagance is regarded as a bad thing, as doubtless it is, but for the long-range effects there are worse things. If it is wrong, the punishment will come quickly instead of being deferred, as it is when too much construction work is done. It is better probably for the war still to be retarding our progress than for it to leave a stimulus to cause us to make progress at a greater rate than we can safely stand over a period of years.

Books Beat Bullets

ABRAHAM LINCOLN'S homely philosophy endeared him to his contemporaries, and now has exalted his memory to that of an immortal purely because it matched his life and was based on careful thinking from a fundamentally sound set of principles. Therefore many of his sayings are independent of time and place—to the point then, they still apply to modern problems, and will be quoted for guidance again and again.

How aptly significant are the words: "Rattlesnakes and panthers and Indians know the fighting game and have weapons for the purpose, but this sort of fighting will never make the world a better place to live in. If the world ever gets to be the kind of a place you ask GOD for when you pray, 'Thy kingdom come,' it's coming by brains and hearts instead of claws and fangs. You can't shoot sense nor religion into a man any more than you can beat daylight into the cellar with a club. Take a candle in, and the thick darkness disappears; just so give the people knowledge and their ignorance and intolerance and other devilment will disappear. I haven't lived so powerful long yet, but I have lived long enough to make up my mind that for the good of all mankind, books beat guns."

Chemical and Physical Constants

RESOLUTIONS were adopted at the Savannah meeting of the American Institute of Chemical Engineers cordially supporting the committee of trustees organized to undertake the business arrangements for the great work of establishing, bringing together, editing and publishing these enormous compendia of fundamental data.

Their first step is to raise $200,000, and they are entitled to the earnest and hearty support of American chemical industry in the effort. These tables are a matter of everyday interest in the solution of technical problems. Let us cite an example of their practical value. A great shipment of fluid merchandise was about to be made in tank cars. The managing director was on the job, and he asked the man in charge how full he was making the tanks. "Filling 'em right up," said he. "Well, stop it," said the manager. "What is the cubical expansion of this material?" Nobody knew. "Look it up in Landolt and Börnstein." It was not given there. "Then make a determination in the physical laboratory." This was done, and found to be about ten times that of water. The whole shipment might have been lost by a warm wave if this constant, which is nowhere given in the literature of the subject, had not been determined.

It has been said in Germany many times that their scientific literature lost them the war. In so far as we encouraged the Germans to publish everything we needed in their own way, and in their own language, this is true. When the war came on there was no less than a scramble on behalf of the Army, Navy, Airplane, Medical, Shipbuilding and Explosive Departments and Commissions, the National Research Council, the Council of National Defense, etc., all wanting Landolt and Börnstein's Tabellen—and hardly enough to go around!

Now, the Landolt and Börnstein tables are inadequate and incomplete, and in many respects incorrect. They are the best there are that are published and available, but they are not good enough for the needs of intensive chemical research and industry. There's no use trying to introduce any pseudo-practicality by calling only for compendia that are "likely" to be needed. Who knows what constants he will need before he knows his problem? And they must be right. A guess or an "approximate conclusion" as to the melting point of tungsten, or silica, was good enough until tungsten came into use, or firebrick to be really studied, and then the record was found to be wrong!

The time has come, too, when the English language should be made a great medium of expression for chemistry. Many of our chemists coming along and here already do not speak or even read German. They are not of necessity ignorant for that reason. And again, in the Inter-Allied Council and the International Research Council, the United States has agreed to do this thing. It is not a problem for the Senate to wrangle over, there is no politics in it, and the pledge was given by our own duly accredited men of science. Let's go to it, and give these trustees the help they need. They are giving their time and energy without charge. They consist of HUGH K. MOORE of Berlin, N. H., chairman (from the Chemical Engineers); JULIUS STIEGLITZ of Chicago University (from the American Chemical Society), and EDWARD P. HYDE of Cleveland, (from the American Physical Society).

Western Chemical and Metallurgical Field

Notes on Magnesite Refractories

THE continuation of domestic dead-burned magnesite as the source of supply of the raw material for the refractory magnesite industry in this country depends upon the clarification of prevalent ideas regarding quality, supply, and cost to the consumer per unit of finished product, contingent upon the use of this material. Few of the factors pertinent to the manufacture of brick of excellent quality are understood by all concerned; the situation has been and is being obscured by conflicting statements and propaganda.

Some consumers assert that brick made from domestic dead-burned magnesite are of an inferior quality; this is regrettably true of a large proportion of the brick manufactured in this country until recently. The unreliability of the brick, together with the high prices which obtained during the war, added materially to the cost of a finished product, decreased furnace efficiency and therefore reduced output. The manufacturers of the brick gave quality of the raw material as the cause. The users had to have the brick regardless of quality or cost. The producers of dead-burned magnesite delivered a dead-burned material which did not produce a brick of good quality when used under the same manufacturing conditions as was the Austrian dead-burned magnesite; both the producer of dead-burned magnesite and the brick manufacturer were more concerned with meeting demands for brick than with the idea of establishing the industry on a quality basis.

QUALITY THE IMPORTANT FACTOR

The question of supply is of less importance than that of quality; there were times of acute shortage during the war, but this condition did not obtain for long. Quite recently the situation again became acute. The producers of dead-burned magnesite had ceased operations, there being no demand for their product. The brick manufacturers had expected Austrian dead-burned magnesite to come in as return ballast in food ships; this supply did not materialize. Users of brick allowed their stocks to become depleted in expectation of lower prices. This combination of circumstances suddenly became apparent, and it was necessary for one of the western producers to re-establish operations, thereby relieving the situation. This answers the question of immediate supply. The reserves in sight are claimed by the U. S. Geological Survey to be ample for at least twenty years at the present rate of consumption.

QUESTION OF MANUFACTURING TECHNIQUE

The production of a magnesite brick of excellent quality is as much a question of manufacturing technique as it is of raw materials. Brick produced from dead-burned Austrian magnesite was the result of twenty years development from this particular material, and the brick makers in this country had established their manufacturing methods around this one source of supply. When it became necessary to manufacture brick from dead-burned domestic magnesite, the unreliable and non-uniform brick produced were admittedly caused by the difference in raw material. The production of an inferior article continued until the producers of dead-burned magnesite had imitated as nearly as was possible the Austrian dead-burned product, producing a satisfactory material, which was accomplished by the addition of iron oxides to the ground magnesite before burning, and the manufacturers had modified their manufacturing methods by alterations suitable to the domestic dead-burned magnesite. The function of the impurities associated with the Austrian mineral were not thoroughly understood, but the addition of iron to the domestic minerals was found to improve quality. California deposits, from which the supply was first obtained, are of the amorphous variety of magnesite, the Austrian deposits are of the crystalline variety; this difference was also thought to be an additional cause for the unsatisfactory product. The development of the crystalline deposits in Washington occurred during 1917. By this time the functions of iron, silica and lime were better understood. Brick has been made, within the last year and a half, from these deposits as well as from the California deposits that are said to be in every way the equal of any produced from the Austrian.

ADAPTABILITY OF AMERICAN MAGNESITE

The crystalline or amorphous nature of the magnesite has no effect on the quality of the product resulting from the burning operation. Either variety is converted into amorphous magnesium oxide at the temperature required to liberate the carbon dioxide, or at about 800 deg. C. The refractory properties of the brick are due to the formation of the crystalline variety of magnesium oxide, which is the mineral periclase. The structural properties of the brick at furnace temperature are due to the size of the periclase crystals, to the completeness of crystallization, to the nature and amount of bonding material and to the nature and amount of other impurities such as iron, lime or silica, which may be associated with or added to the magnesite mineral.

The iron associated with the Austrian magnesite, as carbonate, and that added to domestic magnesite, as iron oxides, acts as a catalyzer in producing periclase, increasing the rate of formation and lowering the temperature necessary for complete crystallization. In order to produce a uniform product the iron and magnesia must be intimately associated. In the Austrian magnesite, this has been done by nature; with the domestic, fine grinding and intimate mixing are essential. Silica reacts with iron oxides to form silicates which are fluid at the temperature required to produce a dead-burned product, between 1450 and 1500 deg., and assist in the uniform distribution of the iron throughout the amorphous magnesia. Iron, silica and lime must not be present in amounts deleterious to the production of brick designed to have maximum strength at furnace temperatures. Silica, and iron combined with magnesia, act as a bonding material for the periclase crystals and the physical characteristics of brick can be controlled by the amount of silica and iron in the dead-burned magnesite used in their manufacture. Finally, press molding and correct kiln operation must be an adjunct to a satisfactory raw material if a superior brick is to be produced.

It appears to be a reasonable claim and an established fact that brick can be produced from domestic dead-burned magnesite, in which the amount of lime and silica has been controlled by selection and blending, that are equal or superior to any yet produced from the Austrian product. Looking into the future, the users of magnesite brick may demand and receive a superior article from the brick manufacturers, and therefore expect a reduction in the cost of this material per unit output.

New Jersey Chemical Society

A MOST interesting program was provided for the December meeting of the New Jersey Chemical Society, which was held at Stetter's Restaurant, Newark, on Monday evening, Dec. 8.

MANUFACTURE OF PAINTS AND VARNISHES

Dr. E. C. HOLTON, chief chemist of the Sherwin-Williams Co., commented briefly upon a series of motion-picture films showing some of the products made by this company. The manufacture of lead-zinc paints was illustrated in considerable detail, from the mining of the mixed sulphide ore through the concentrators and roasters to the mills which grind the pigment in oil, and the filling machines which deliver the product ready for shipment. Numerous views of the different plants of the company served to convey an idea of the magnitude of the organization.

THE LAKE ASPHALT INDUSTRY

The paper on the lake asphalt industry, delivered in the absence of Mr. C. N. Forrest by Mr. J. S. MILLER of the Barber Asphalt Co., proved to be the feature of the evening. Mr. Miller discussed the nature and occurrence of natural asphalt in the lakes of Trinidad and Venezuela. The importance of colloid chemistry in the study of bitumens led the speaker to a general discussion of the colloidal state of matter. Research has demonstrated that the difference in physical properties between natural asphalt and artificial asphalt (obtained as a residue in the distillation of asphaltic-base petroleums) is due to the presence, in the former, of colloidal particles of clay. Owing to their extremely small size, the surface energy of these particles is enormous. This accounts for the superior binding powers of the natural asphalt. Attempts to prepare similar colloidal suspensions of clay in artificial asphalt have not met with perfect success, although progress is being made in this direction.

It is interesting to note that the ultramicroscope proved invaluable in this research, since the particles are too small to be visible in the ordinary microscope. The supernatant liquid from solutions of natural asphalt in benzene which have been allowed to stand undisturbed for six months shows the Brownian movement of the colloidal particles when viewed under the ultramicroscope. Through unlimited perseverance, the research department was able to secure (for the first time) motion-pictures of the Brownian movement. The difficulties encountered in the preparation of this film are readily appreciated when it is considered that the particles to be photographed are smaller than the silver bromide grains in ordinary film. The remarkable results obtained brought forth hearty applause from the members and their guests.

Other films showed the mining of asphalt at the Venezuelan lakes, the necessity of re-mining from the steamer hold, and the making of asphalt roofing.

FILTER PRESSES AND FILTRATION

Mr. C. L. BRYDEN of the United Filters Corporation described the various types of filter presses placed on the market by this company, emphasizing his points on constructional detail by a series of lantern slides showing the Kelly and Sweetland pressure filters and the American continuous filters from many points of view and under various operating conditions.

Priestley's Home Purchased by Penn State Chemistry Alumni

THE original home and laboratory of Dr. Joseph Priestley, the famous chemist who discovered oxygen in 1774, which is located on the banks of the Susquehanna River at Northumberland, Pa., was purchased recently by graduate chemists of the Pennsylvania State College, who plan to move it to the campus and make it a lasting memorial to the great scientist.

Upon learning that the Priestley homestead, which was built in 1794-96, was to be put up at public auction, the Penn State chemists sent as their representative to the sale Dr. G. G. Pond, dean of the School of Natural Science at the College. He was successful in making the purchase, and thereby was able to announce that the old historic mansion would be preserved in its original lines.

Expert architects from the College will at once make the necessary surveys preparatory to the work of moving the Priestley home from Northumberland, Pa., to the campus at State College, a distance of about 60 miles. While the purchase of the home has been made by Dr. Pond for the Penn State chemistry alumni, who are scattered to all parts of the country, funds for its removal and erection on the College campus will be supplied by an as yet unnamed donor. Actual work of removal will probably be started in the spring. The reconstruction on the College campus will be along the old architectural lines, but modernized and adapted to some suitable use by the School of Natural Science, according to present plans.

Dr. Priestley's career as a scientist in the last half of the eighteenth century was one that has established him as one of the greatest in history. He is credited with the discovery of oxygen and many of its properties in his laboratory in England in 1774. About the same time he discovered ammonia and hydrochloric acid, and a year later, in 1775, he was credited with the discovery of sulphurous acid gas. Within another year he found nitrous oxide (laughing gas). His discovery of nitric oxide dates from 1772. A large amount of his experimental work was conducted after 1780 in Birmingham. He was a noted dissenter in religious views and was persecuted in England for his Unitarian teachings and activity. His house in Birmingham was mobbed and all of his chemical and physical apparatus destroyed. He was made uncomfortable in London, and, not being sure of his life, he came to America in 1794. His sons had preceded him. He settled at once at Northumberland and built the Priestley mansion there. He continued his experiments there until his death, in 1804. He was buried at Northumberland, and the house and grave have been visited by interested persons from all parts of the world.

In 1874 a large number of chemists gathered there to celebrate the 100th anniversary of the discovery of oxygen. These chemists formed the nucleus of what is now the American Chemical Society. One speaker on that occasion said: "Of the most important gases known at present, we owe nearly three-fourths to Priestley.

Dr. Priestley was a prolific writer, quite as much on religious as on scientific subjects. He was a vigorous and incisive teacher and preacher. His political principles found no favor with the Adams administration, and it is said that at one time he was threatened with expulsion from the country. However, he was a very ardent supporter of Jefferson, and was offered the position of Congressional chaplain, which he refused. His discoveries in chemistry would have established the fame of half a dozen ordinary workers, yet in his own opinion most of his results were accidental. One of the most important discoveries that he made at Northumberland was the fact that plants inhale oxygen in sunlight, and that oxygen turns dark venous blood red.

Beverage Exposition Features Chemical Equipment

THE Beverage Exposition and meetings of four associations held simultaneously in Chicago, Nov. 1 to 9, was an occasion of the largest gathering of the soft-drink industry representatives ever witnessed. The people engaged in this business have been very much in a quandary as to what the future holds, and this series of meetings was projected to help clarify the situation. This was the first show of its kind, and beyond all expositions that have previously been witnessed at the Coliseum was the most befitting combination of attractions for the general public on one hand and of deep interest to the industrial visitors on the other.

The industrial exhibits were the main feature of the exposition. In addition to the bottling machines, bottles and bottle washing machines, trucks, soft drinks, cereal beverages, soda fountain supplies and specialized equipment peculiar to the industry, there were many items of interest to the chemical business.

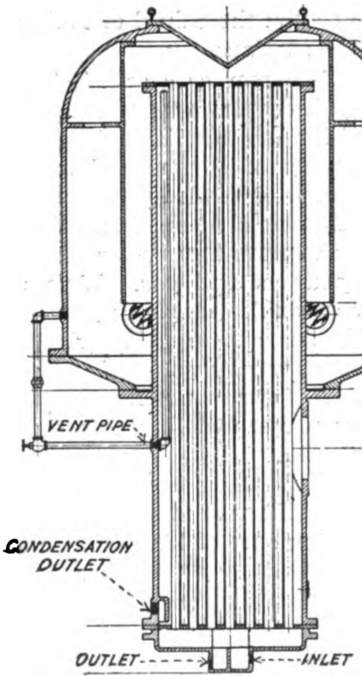


FIG. 1. RAPID CIRCULATION EVAPORATOR

Evaporating and De-alcoholizing Apparatus

A special type of evaporator, known as the vertical rapid circulation evaporator, was shown by the Buffalo Foundry & Machine Co. Fig. 1 illustrates the apparatus in section. It employs the high velocity principle, thus keeping the tubes clean—an essential point in handling food products. It is particularly adaptable to the concentration of thin liquids of foamy nature, or organic solutions which should be exposed to heat for only a short length of time. This makes it suitable for malt extracts, fruit juices and de-alcoholizing beers and wines.

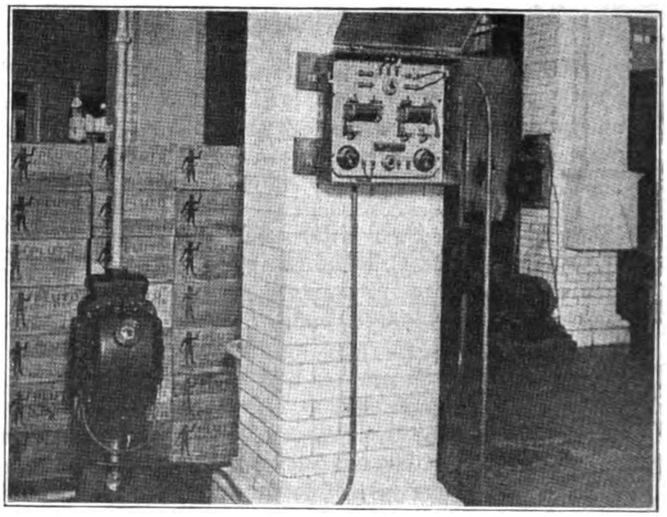


FIG. 2. STERILIZING PLUTO WATER BY ULTRA-VIOLET RAYS

Vacuum evaporators for the removal of alcohol from fermented beverages without impairing the taste or character of the product were exhibited by the Hercules Engineering Corporation, and Joseph Schneible. The latter also showed sections of larger continuous stills capable of producing in one operation alcohol up to 192.5 proof, the residual beverage having zero alcohol content.

Filters

Since many beverages are susceptible to contamination or discoloration in contact with iron, filter presses having a cast iron shell and all brass, bronze or copper internal construction are used. A recent development of the United Filters Corporation is a special all-aluminum press, which is an item of value to the chemical industry generally, for the handling of corrosive liquids.

A demonstration was made of the manner in which Filter-Cel assists filtration of turbid liquids, by improving the clarity of filtrate, increasing capacity of equipment, decreasing labor of cleaning press, shortening the process and avoiding dilution in washing.

Glass-Lined Equipment

Glass-lined steel tanks and containers are extensively used for storing beverages and beverage syrups. The exhibits of Elyria and Pfaudler products were so arranged as to show the flawless character of the linings.

Recording and Controlling Instruments

The possibilities of automatic control of temperature, pressure, etc., in manufacturing processes were illustrated by an excellent line of "Tycos" and "Tag" specialties.

Sterilizers

Two methods of sterilizing were shown:

(*a*) By ultra-violet light. James B. Clow & Sons demonstrated a Type H-2, 1000-gal. per hr. ultra-violet-ray sterilizer, together with a small 120-gal. Type B-2. The number of these machines in commercial plants has demonstrated their efficiency for this class of work.

(*b*) By ozone. The Electric Water Sterilizer & Ozone Co., Scottdale, Pa., operated a sterilizer unit consisting of ozone-producing and absorption apparatus mounted en bloc, capacity 550 gal. per hour, and an electric water sterilizer, operating on the electrolytic principle, capacity 1000 gal. per hour.

BOTTLING AND REFRIGERATING PLANTS

Complete low-pressure bottling and refrigerating plants were displayed by the Liquid Carbonic Co. in a booth specially constructed in black and silver. The total effect was pleasing to the eye and the operation most instructive. The management was congratulated on every hand on its success in bringing together so scattered a trade as the beverage industry, thrown into exceptional confusion by the present novel conditions. The officers of the Beverage Exposition are: President and general manager, Felix Mendelsohn; secretary, Henry E. O. Heinemann; treasurer, P. M. Harwood. The headquarters are 1253 S. Michigan Ave., Chicago, Ill.

Chemical Warfare Service

TWO recent developments favoring the continuation of the Chemical Warfare Service as a separate unit have been the adoption of a resolution by the American Electrochemical Society and the appearance of Major General Sibert before the House Committee on Military Affairs.

At the October meeting of the board of directors of the American Electrochemical Society, President Bancroft submitted a report of the committee on resolutions regarding Chemical Warfare Service. The resolution, copies of which were forwarded to the members of Congress and the Army authorities concerned, is as follows:

AMERICAN ELECTROCHEMICAL SOCIETY RESOLUTIONS

"Whereas the development of science and research is of paramount importance not only to the military establishment of the United States, but to the welfare and security of the entire nation; and

"Whereas the bill introduced into Congress for the reorganization of the Army (Senate 2715, 66th Congress) is not only clearly destructive of the Chemical Warfare Service, but is so drawn as to belittle all scientific and technical work in the Army and make it subordinate to the unscientifically trained officer; Therefore, be it

"Resolved, that the American Electrochemical Society urges strongly that any legislation for the reorganization of the Army shall provide for the continuing of the Chemical Warfare Service as a separate staff bureau as at present; shall provide for the commissioning of staff officers in the corps and departments in which they are to serve; and shall in general accord to the technical man full recognition and opportunity throughout every grade and department of the military establishment."

GEN. SIBERT'S TESTIMONY

The appearance of Major General William L. Sibert, the director of the Chemical Warfare Service, before the Committee on Military Affairs of the House of Representatives, brought out little information that had not been presented earlier to the Senate committee, or has been set forth in the various published articles by General Sibert and other officers of the Chemical Warfare Service. In making his plea for an organization separate from the Engineer Corps, or the Ordnance Department, General Sibert pointed out the evils of having a unit too large for efficiency. Speaking of the Ordnance Department, he said that "when any branch of the service becomes so extensive in its various elements of work that no one man can keep sufficiently acquainted with the details of those various elements so as to direct them intelligently, it then is time to divide such an organization into smaller independent units." He pointed out that the chemical work of the Ordnance Department is not extensive, since the chemistry of powders is not a very big subject. The Ordnance, he said, is essentially a mechanical engineering department.

The chairman of the committee called General Sibert's attention to the statement by the Chief of Staff that it would be difficult to carry on experiments with gas around populous centers. General Sibert replied by citing the fact that experiments have been in progress for two or three years with all kinds of noxious and toxic gases at American University, which is practically in the City of Washington.

General Sibert testified that at present gas experiments are being conducted only in a very small way. This is due to the fact that equipment is now being moved from American University to the Edgewood Arsenal. In addition, the General Staff has not had an opportunity as yet to pass upon the program which General Sibert has proposed for field work. He stated, however, that the service is beginning to provide gas officers for the various infantry divisions. He took advantage of several opportunities to make clear to the committee the value to a nation of large chemical industries.

Imports Into Canada During the Past Two Years

Trade statistics as issued by the Canadian Government show that the imports into the country from the United States decreased from $752,810,282 for the 12 months ended July, 1918, to $695,268,163 for the year ended July, 1919. During the same time exports to the United States increased from $411,860,008 to $431,705,058.

Exports to Great Britain fell from $744,380,550 for the year ended July, 1918, to $546,866,571 for 1919; exports to France fell off from $150,597,165 to $80,945,701 during the same period.

The value of some of the principal articles imported into Canada for consumption during the past two years is shown in the following table:

	Twelve Months	Ended July
Articles	1918	1919
Articles for army and navy	$77,753,452	$27,573,380
Asphaltum and asphalt	361,950	385,380
Books and printed matter	6,645,730	8,704,152
Breadstuffs	20,436,388	21,488,310
Bricks, clay, and tiles	4,643,527	3,022,649
Chemicals	29,845,615	25,468,964
Coal:		
Anthracite	27,469,699	28,189,872
Bituminous	46,896,893	37,413,847
Cotton	64,795,347	65,192,086
Earthen and china ware	2,321,030	2,480,181
Flax, hemp, and jute	12,171,111	13,477,214
Furs	4,506,416	5,105,633
Hides and skins	7,069,342	7,936,129
Leather	10,493,774	11,163,097
Meats	13,263,400	16,488,031
Metals:		
Brass	5,074,550	4,657,851
Copper	6,290,813	6,028,100
Gold and silver	297,259	308,147
Iron and steel	156,322,603	151,172,247
Lead	1,288,813	626,386
Tin	14,570,566	11,975,234
Zinc	1,643,725	880,025
Paints, color, and varnish	3,341,986	3,262,580
Paper	7,542,037	8,813,815
Rubber	12,794,619	11,343,353
Soap	1,248,613	1,001,099
Stone, marble, and slate	1,987,642	2,265,614
Sugar and molasses	36,465,940	47,946,288

Cellulose Symposium

THERE was an interesting symposium on cellulose at the regular meeting of the New York Section of the American Chemical Society held at Rumford Hall in the Chemists' Club on Nov. 14. The first paper was by Mr. Wallace P. Cohoe, and had to do with "Present Day Problems in Regard to Cellulose."

There is a tradition, he said, that quick-growing plants do not make good paper, but this he declared to be erroneous. Bamboo and flax straw are excellent materials, and hemp and jute wastes are important for the purpose. Bagasse has not been profitable, so far, but in this respect it is possible that the final word has not been said. The uses of paper and pulp are constantly increasing, and new sources must be found. Among new uses he cited the nitration of wood pulp and artificial silk as important consumers. Rugs are made of mixtures of paper yarns with cotton and wool. The yarns made of paper fiber have slight holding power when wet and they must be heavily sized, which tends to make them heavy and stiff. Sisal and jute may be used for making paper, and good results are obtained from freshly handled manila waste. In Germany a great deal of paper cloth has been used for bed ticking. Paper burlaps are coming into use. The future of paper textiles, however, is not promising for human wearing materials. The art of the hydration of paper-making fiber has not yet been discovered.

Cellulose is at once perishable and permanent. Millions of tons are produced every year and turned back into the soil, and yet cloths from the tombs of the Ptolemys are still good and strong. We are still at sea in regard to the chemistry of cellulose.

Professor R. H. McKee of Columbia remarked in regard to paper materials that we had not yet adequately addressed ourselves to their proper culture. We use very little wild rice and no wild wheat, because the yield is so slight, nevertheless in reforestation we plant wild rather than hybrid trees.

Wild bamboo grows a foot a day, but our forest woods are usually of slow growth. New hybrids of trees have been developed that grow very fast. He spoke of a poplar hybrid that grew 27 ft. in 27 months, and a walnut hybrid that achieved remarkable growth, and yet the wood of these was no softer than that of the original stocks. He urged a greater encouragement of the study. If chemists lead in encouraging foresters to develop fast-growing trees to meet present and future needs, the woods are likely to be forthcoming.

Dr. Harold Hibbert made an earnest plea for a close study of the cellulose molecule, and he noted that more particularly the American chemical journals had been less diligent in this respect than their British and German contemporaries. The difference between monomolecular cellulose and sugar is one molecule of water, so that cellulose may be described as dehydrated sugar. Now, although the hydration of cellulose is not an accomplished fact, it certainly would be worth while to develop the art, and he believed that in view of the immense importance and scope of the cellulose industry, a Government institute should be founded to work on cellulose. He proposed an interesting hypothesis in regard to the structure of the cellulose molecule which may appear later in an original paper.

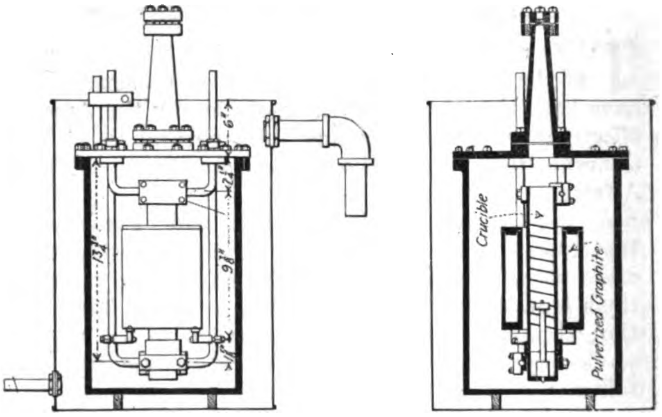
Dr. J. E. Miner presented a paper on her studies on cellulose hydration problems, and Messrs. Hamilton and Bradshaw gave their experience in the du Pont establishments with the nitration of wood pulp.

The Chicago Electrical Show

THE Electrical Show held in the Coliseum at Chicago Oct. 11-25, while in the main an exhibit of interest to the general public in its displays of household appliances and lighting fixtures, contained a few items of value to the chemical industries.

The Booth Electric Furnace Co. had a corner displaying some products of the furnace and photographs of the new designs. The Detroit Electric Furnace Co. showed a 500-lb. rocking furnace. Both the Edison Storage Battery Co. and the Electric Storage Battery Co. exhibited various sizes of storage batteries and accessories. The Elwell-Parker Electric Co., displayed two of the small industrial vehicles for use in warehouses and for indoor transportation throughout the factory. The Thomson Electric Co. advertised electric metal working machinery.

One display of particular note in ceramic work was contained in a glass case at the booth of the National Lamp Works. The ingredients for manufacturing the milk-white glass used in forming the new "White Mazda" incandescent lamp bulbs were contained in small crucibles adjacent to the finished product. They were labeled Litharge, Soda Ash, Feldspar, Fluorspar, Silica Sand and Niter. Relative quantities were not given.



SMALL VERTICAL VACUUM FURNACE

A small laboratory type of electric vacuum furnace was exhibited by the General Electric Co. This is shown in the figure and contains a heating element of graphite wound as a helix within a steel vacuum chamber with lead gasketed joints.

A crucible of carbon, graphite, alumina, tungsten or other refractory required for the material to be treated is placed in a chamber within the helix. The temperature may be brought to any desired point up to 3100 deg. C. and the performance noted through a mica window in the top of the furnace. At 3100 deg. C. the power consumption is 15 kw. Maximum size of crucible which can be inserted is 1.5 in. in diameter and 4 in. high. This furnace may be adapted in the preparation of metals, alloys, carbides and silicides; in determining melting points of refractories, metals, etc.; in calibration of optical pyrometers; in distillation of refractory substances, and in study of equilibrium in reactions depending upon the pressure of the gaseous phase. Excellent quantitative results are said to be obtained with this device.

The Commonwealth Edison Co. displayed an electrical design over the door which outlined in lights the increase in cost curves of food, clothing and rents as compared with the decreasing cost of electric power.

Chemical Warfare Service Wants Recruits

Men with chemical and engineering experience are being called upon by the Secretary of War to enlist with the Chemical Warfare Service. It is the desire to obtain 1000 recruits at the earliest possible date. Enlistments are for 1 or 3 years. The men will be enlisted in the infantry, but assigned to the Chemical Warfare Service.

With the Chemical Warfare Service calling for recruits on the one hand, and asking assistance in placing some of its men in civilian positions on the other, it would seem that a conflict exists. As a matter of fact, however, there is no conflict, as the men being recruited are to serve as privates, while the men for whom positions are being sought are officers who desire to be relieved from service. Approximately 40 per cent of the officers remaining in the Chemical Warfare Service want to return to civilian employment as soon as a position that is sufficiently attractive opens. As practically all of the enlisted men in the Chemical Warfare Service had come in for an emergency only, they have been mustered out, and it is now necessary to build up a new enlisted personnel.

The Army Reorganization bill is taking form, with the probabilities pointing to the recognition of the Chemical Warfare Service as a distinct branch of the Army.

New York Section Meeting, American Chemical Society

At the December meeting of the New York Section, held on the evening of Friday, Dec. 5, in Rumford Hall, the following officers were elected for 1920: Chairman, Ralph H. McKee; vice-chairman, John E. Teeple; secretary-treasurer, Herbert G. Sidebottom; executive committee, D. W. Jayne, C. H. Herty, F. J. Metzger and K. G. Mackenzie. In addition, twenty councilors were chosen to represent the Section.

The technical program for the evening was opened by Dr. K. George Falk of the Harriman Research Laboratory, Roosevelt Hospital, who spoke on "New Methods of Food Dehydration." This method of dehydration, which consists in heating the food product at a relatively low temperature in a vacuum, was developed primarily for the purpose of preventing spoilage of meat during transportation in war time. Details of the process have been published in the *Journal of Industrial and Engineering Chemistry*.[1]

This paper precipitated a lively discussion in which Prof. S. C. Prescott of the Department of Agriculture took an active part. He has done a great deal of work on the air-blast dehydration process[2] and argued strongly in favor of this method.

The latest advance in this method is drying by means of moist warm air, which sounds paradoxical but is in reality most logical. The drying operation is started with warm air containing a carefully regulated amount of moisture so that only a portion of the moisture in the food product can be taken up by the warm air. As the drying proceeds, the percentage of moisture in the incoming warm air is diminished progressively, until at the end dry air is used. The process is in effect an application of the counter-current principle. It is claimed that by this method the original flavor and palatability of the food are retained.

The program was concluded by a very interesting paper on "Emulsions," presented by Dr. A. W. Thomas.

Fixed-Nitrogen Corporation Proposed

Manufacture, production, and development of atmospheric nitrogen for military, agricultural, and other purposes is provided in a bill introduced simultaneously in the Senate and the House of Representatives. The bill was drafted in the War Department. It provides for the creation of the United States Fixed-Nitrogen Corporation. The stock in the corporation is to be owned exclusively by the Government. The bill empowers the Secretary of War to designate any five persons to act as an organization committee with authority to organize the corporation.

Among other things the corporation is to have the power to make contracts, appoint a board of directors, other officers and employees and to fix their salaries. The corporation may sue and be sued. It is to be conducted under the supervision of a board of directors consisting of not less than three nor more than 11 members, to be appointed by the Secretary of War. They are to hold office at the pleasure of the Secretary of War. The board of directors is to perform the duty usually appertaining to the board of directors of private corporations.

The corporation is to have the power to purchase, operate, and develop the nitrate fixation plants numbered 1 and 2, located respectively at Sheffield and Muscle Shoals, Alabama, together with the machinery, real estate, and laboratories pertaining thereto. This is to include the research laboratory at Washington, the Waco Limestone Quarry in Alabama, and the Electric Power Unit at the Warrior River Station of the Alabama Power Co.

After its completion the hydro-electric power plant now being constructed at Muscle Shoals is to be operated by the corporation. The corporation is also authorized to purchase, lease, or otherwise acquire United States or foreign patents and processes. It also may sell and export any of its surplus products not purchased by the United States or by persons within the United States.

The Question of Fuel Oil in France

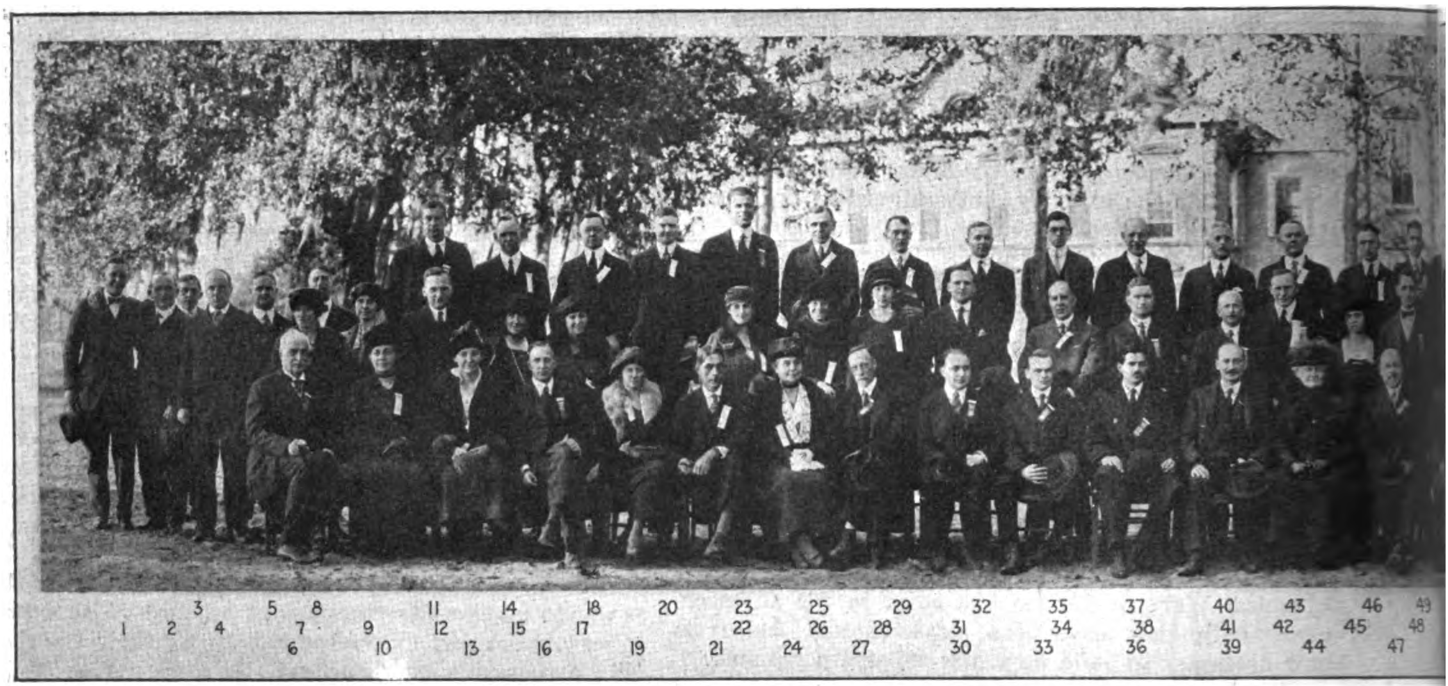
A commission presided over by M. Henry Bérenger, Commissaire Général aux Essences et Combustibles, has been set up by the French Minister for Public Works to study the question of oil fuel in France. The following three decisions have already been arrived at: (1) The substitution of heavy-oil fuel for coal everywhere in the heavy industries and all public services is of the greatest possible urgency. (2) A progressive program is to be worked out for the adaptation of boilers and plants to burn oil fuel as from Nov. 15. (3) An organization is to be set up for at least five years for the national supply of heavy-oil fuels in co-ordination with the scheme for importing and producing coal. M. Bérenger and General Gassouin are to be in charge of the scheme in co-operation with the City of Paris and the Minister of Reconstruction.—*Iron and Coal Trades Review*, Nov. 21, 1919.

---

[1] "Low Temperature-Vacuum Food Dehydration." K. George Falk, Edward M. Frankel and Ralph H. McKee, *J. Ind. Eng. Chem.*, Nov. 1, 1919, p. 1036.

"The Work of the Harriman Research Laboratory, Roosevelt Hospital, New York City, in Affiliation With the Division of Food and Nutrition, Medical Department, U. S. Army." K. George Falk, *J. Ind. Eng. Chem.*, Nov. 1, 1919, p. 1062.

[2] "Relation of Dehydration to Agriculture," U. S. Department of Agriculture, Circular 126, Jan. 25, 1919.



AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

2, W. V. Davis. 4, Wallace Savage. 5. G. S. Patton. 6, F. W. Frerichs. 7, Mrs. May Helmley. 8, C. V. Snedeke. 9. Mrs. George S. Patton. 10, Mrs. F. W. Frerichs. 11, Augustus H. Fiske. 12, S. Felton Grove. 13, Mrs. Hugh K. Moore. 14, Wilbur L. Wright. 15, Mrs. Augustus H. Fiske. 16, Hugh K. Moore. 17, Mrs. Weir Gilmer. 19, Mrs. David Schwartz. 20, Alvin C. Goetz. 21, Frank N. Smalley. 22, Mrs. W. R. Clymer. 23, Clarke E. Davis. 24, Mrs. A. H. Hooker. 25, T. L. B. Lyster. 26, Miss Ottilie Prochazka. 27, A. H. Hooker. 28, Miss Hildegarde Frerichs. 29, L. G. Yankee. 30, William H. Gesell. 31, James Munn. 32, George A. Richter. 33, S. P. Miller, 34, Arthur E. Rice. 36, E. T. Marceau. 38, W. R. Clymer. 39, J. Bebie. 40, J. F. Wilkinson. 41, George D. Rosengarten. 42, F. I. Gibson. 43, A. Purcell. 44, Mrs. David Wesson. 45, Mrs. F. I. Gibson. 46, P. A. Heavitt. 47, David Wesson, Pres. 48, E. P. Poste. 49, Edward F. J. Puckhaber. 50, M. H. Gwynn. 51, Fred C. Zeisberg.

Chemistry and the South*

An Exposition of the Interrelation Between Fuel, Power, Cellulose and Mineral Wealth, With an Indication of the Future Advance in Southern Industry When Founded on Its Obvious Advantages

BY ARTHUR D. LITTLE

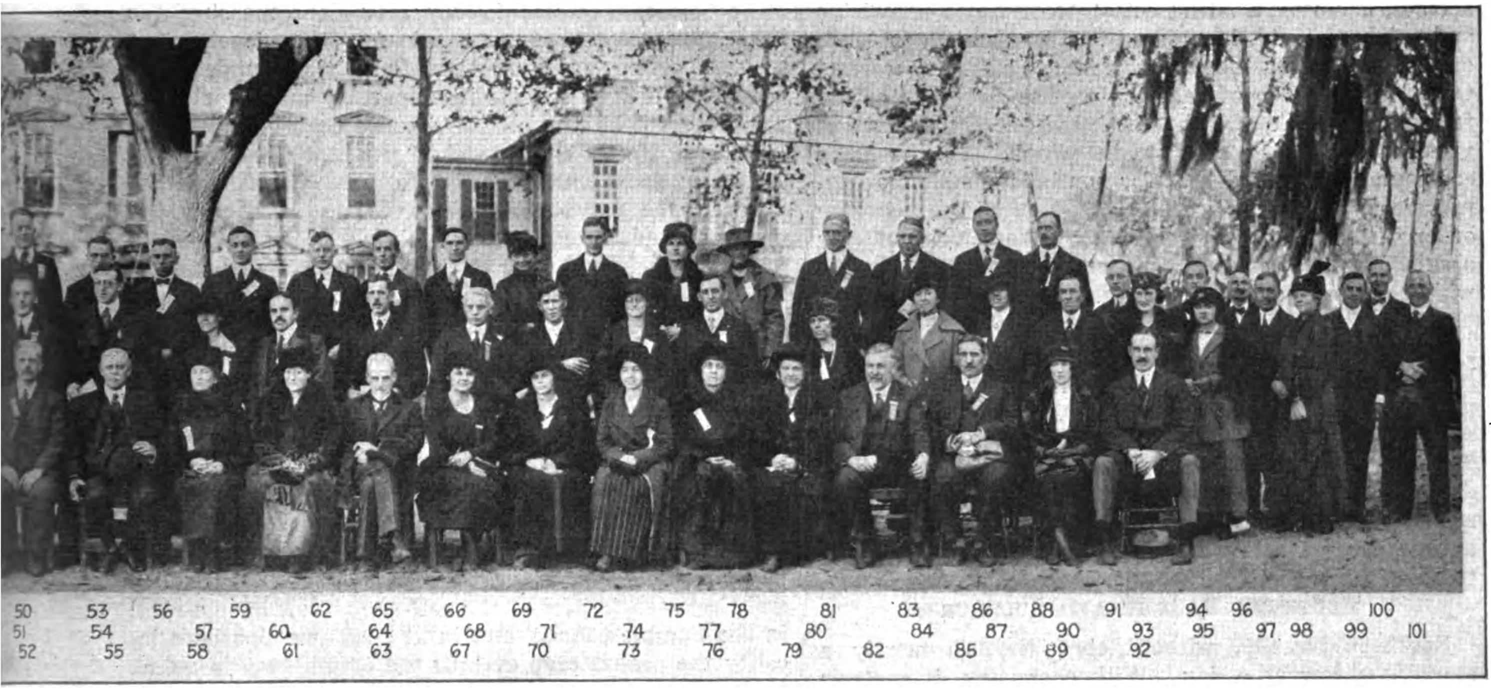
THE American Institute of Chemical Engineers is composed of men who are above all intensely practical, men who make it their life work to apply chemistry to useful ends. We have come to Savannah not merely to enjoy a proverbial and graciously extended hospitality, but chiefly because we recognize that here there is much for us to learn. Your cotton oil mills, your great fertilizer factories, the secrets of your naval stores industry, the doors of many plants distinctively Southern in their type have been generously opened to us. We shall take with us on our return new and enduring impressions of Southern courtesy and kindliness, convincing evidence of the magnitude of industrial achievement in the South, and a new appreciation of the wealth of resource and of opportunity in this supremely favored section of our country, but our mission will have failed unless we leave behind us a message so vital and direct in its importance that it secures and holds your attention and thereafter influences your action. And that message in a word is this: "The future of the South is in chemistry."

To insure acceptance any such general thesis properly requires demonstration. Suppose we begin by considering for a moment what the South already owes to chemistry.

The manufacture of fertilizers and the effective use of these artificial manures in the growing of crops are obviously based on chemistry and controlled by the laboratory findings of works chemists, the experiment stations, and the Bureau of Chemistry. The farmer, wiser than most purchasing agents, buys an analysis. Agricultural chemistry, with all that it means to the South, began in the laboratory of Liebig and gained recognition in this country chiefly through the writings and work of Johnson. The essential elements with which growing crops must be supplied are potash, ammonia, and phosphoric acid. It was the refined and classic work of the Dutch chemist Van't Hoff in physical chemistry which rendered possible the separation of the potash from the salts of the Stassfurt mines; the world has long derived its ammonia from the chemical processes of the gas works and by-product coke ovens; today it turns to the atmosphere for the larger supplies of ammonia and nitric acid which its growing needs demand and secures them by the chemical and electro-

---

*Presidential address (slightly abridged), American Institute of Chemical Engineers. Twelfth annual meeting, December, 1919, Savannah, Georgia.



PHOTOGRAPH TAKEN AT SAVANNAH, GEORGIA

52, John C. Olsen, Sect. 53, P. A. Heavitt. 54, B. R. Tunison. 55, Arthur D. Little. 56, W. H. Scott. 57, Elizabeth Ravenel. 58, Mrs. A. D. Little. 59, Alden K. Boor. 60, H. A. Edgecomb. 61, Mrs. Geo. A. Prochazka. 62, A. L. Christiansen. 63, George A. Prochazka. 64, A. E. Gibbs. 65, Frank T. Laird. 66, Herbert P. Strack. 67, Mrs. Fred C. Zeisberg. 68, J. T. Baker. 69, Mrs. J. H. Allen. 70, Mrs. Earle C. Pitman. 71, Brian S. Brown. 72, J. Henry Allen. 73, Mrs. B. R. Tunison. 74, Mrs. F. N. Smalley. 75, Mrs. V. H. Bassett. 76, Mrs. F. E. Dodge. 77, Leo M. Wachtell. 78, Mrs. R. F. Montsalvatge. 79, Mrs. John T. Baker. 80, Mrs. G. W. Thompson. 81, Gustave W. Thompson. 82, Frank E. Dodge. 83, George M. Davidson. 84, Mrs. G. M. Davidson. 85, Charles L. Reese. 86, W. H. Irwin. 87, Mrs. S. E. Seaman. 88, Philip Shuey. 89, Mrs. J. D. Bourne. 90, Richard K. Meade. 91 William R. Hulsizer. 92, J. E. Crane. 94, W. M. Whelpley. 95, Miss Lola Mae Vinson. 97, Albert W. Smith. 98, Mrs. A. W. Smith. 101, W. V. Davis.

chemical methods of nitrogen fixation, which, incidentally, have placed new values on Southern water powers. The nitrogenous fertilizer cyanamide is a direct descendant of calcium carbide, first produced commercially by Willson at Spray, North Carolina. The essential constituent of phosphate rock is rendered available by treatment of the rock with that basic chemical product sulphuric acid, while chemical processes have brought into use and service the low-grade ores contaminated with fluorine and alumina.

At the recent World's Cotton Conference in New Orleans it was stated that in growing cotton there was used on a one-horse twenty-seven acre farm selected as a type six and three-fourths tons of fertilizer worth $391.50 and one ton of nitrate of soda worth $90. The figures gain significance when we consider that the pre-war acreage, now somewhat reduced, was 37,000,000 acres.

Upon this vast expanse the South has annually raised for years an average of about 13,000,000 bales of cotton. The 1919 crop is estimated at 11,000,000 bales of staple worth about $150 a bale, with 5,000,000 tons of seed valued at $70 a ton—a total increment to Southern wealth of at least $2,000,000,000.

In no small proportion these values are due to chemistry. If they are attributed to the war we have only to reply that without chemistry the war could not have been fought at all, while in the absence of guncotton, which is merely cotton plus chemistry, it could only have been fought at great disadvantage to our allies and ourselves.

But we are happily now concerned with the peacetime uses of cotton. How far has chemistry extended them and put new values on the cotton crop? Cotton bleaching, which permits its use in fabrics of the finer sorts, is based primarily upon the discoveries of Schule, Weldon, LeBlanc, and Solvay, chemists all of them, and with the exception of the discoverer of chlorine, chemical engineers. Dyeing and printing, which so greatly promote the sale of cotton fabrics, involve pretty much the whole range of chemistry and are tied into its most modern developments, physical and colloid chemistry. The mercerizing process as ultimately developed by Thomas and Prevost imparts to cotton a wonderful silky luster and resulted in an enormous extension of its use in fabrics of the higher grades.

You will again be surprised to know that at least 2,000,000 spindles are to-day engaged in the business of converting cotton into automobile fabrics. There are 150,000 tires consumed daily. Within one or two years the tire production will have increased by 50 per cent, and spindles to the number of 1,000,000 more in this one industry will call to the South for new supplies of cotton.

CELLULOSE

Cotton in its purified form is the type of that wonderful substance cellulose, the structural basis of all plants and thereby the greatest structural material in all the world. The South has an interest in the chemistry of cellulose, for of it her forests are builded and on it her entire agriculture depends. The discovery of nitrocellulose by Schönbein in 1845 has resulted in an extraordinary concatenation of industrial, economic, and political consequences. From it came smokeless powder, the guncotton in the war heads of German torpedoes, the collodion of the surgeon, artificial silk, celluloid in countless shapes, substitutes for leather, the moving-picture films, the finish on brass beds, and the eyelets on our shoes. The South must credit Schönbein with the values placed on cotton linters and the shorter fibers adhering to the hull.

A more recent but analogous compound, cellulose acetate, made by treating cotton with acetic anhydride and sulphuric acid, has already attained an importance only secondary to the nitrate in the arts of peace and war. In the form of cellulose acetate Southern cotton functioned high above the battlefields of Europe as the protective covering of airplane wings. To the same compound we are indebted for non-inflammable moving-picture films, for artificial silk of an altogether new order of merit, artificial bristles and horsehair, and for a substitute for celluloid wholly free from the dangers which always attend the manufacture and which sometimes accompany the use of this ubiquitous material.

But chemistry does not stop with the cotton fiber; it has enriched the South still further in the values it has put upon the cottonseed which once clogged Southern streams. Cottonseed today is worth $70 a ton because chemists have derived from this nuisance of pre-bellum days—it is hard to recall the Civil War, to which I now refer—edible oil, a solid substitute for lard, soap stock, a concentrated cattle feed, and residues of high fertilizing value.

SOUTHERN BAUXITE AND SULPHUR

Southern bauxite, without chemistry, is merely a stone to throw at a dog. With chemistry, it controls the aluminum industry of the world. Louisiana sulphur lay secure beneath 500 ft. of quicksand until the chemical engineer Frasch brought it to the surface by methods so simple and so cheap that the groaning Carusi of Sicily were released from their intolerable burdens and set to work in sunshine on the soil whereunder they had toiled.

But why has sulphur any value in Sicily or Texas or Louisiana? Solely because the co-ordinated studies of generations of chemists have made it the foundation stone of modern chemical industry. As such it functions in sulphuric acid in countless reactions through the whole range of manufacture.

The largest sulphuric acid plant in the world is at Ducktown, Tennessee, but here the acid is made from smelter smoke and constitutes a striking example of a nuisance transformed by chemistry into a profit. Eight hundred tons of Southern sulphur are used each day in America alone, to an annual value of $7,000,000, because fifty years ago Tilghman, in Philadelphia, applied chemistry to the production of wood fiber for use in paper making.

Because Braconnot, in 1819, converted cellulose to fermentable sugars great plants are now operating in Louisiana and South Carolina converting the wood wastes from yellow pine lumber mills into ethyl alcohol. A Southern chemist, Charles H. Herty, held in honor and affection by chemists everywhere, has revolutionized your naval stores industry. Moreover, an actual $500,000 and a potential $1,000,000 at least has been added to the annual value of the turpentine crops by a simple change in chipping method based on studies made in France on the pathology of the wounded tree.

OTHER NATURAL SOUTHERN PRODUCTS

Statistics often prove without convincing. They may compel the reason to assent without firing the imagination or arousing the will to action. I believe, however, that no one with the capacity to understand their true significance can review the colossal figures which set forth the natural resources of the South without first being stunned and overwhelmed and soon thereafter filled with the vision of their stupendous possibilities.

The South contains in superabundant measure the basic raw materials required for the development of great groups of co-ordinated industries founded upon chemistry and on a scale incomparably more vast than anything yet known. She has more than half the iron ore in the United States and 75 per cent of all the coking coal; great stores of lignite, natural gas, and oil. Here is the purest salt which occurs in nature, the cheapest and purest sulphur, clays endless in variety and extent, bauxite for aluminum and for abrasives, limestone adjacent to coal and iron, phosphate rock, gypsum, barytes, shale and quartz, ores of zinc and manganese, lead and nickel, titanium and tin. There is enough wood waste to supply the country's need for paper, and the world must soon look to the stumps on millions of acres of cut-over lands for its rosin and its turpentine. The cotton fiber is itself the raw material for many chemical industries of magnitude, and the short hull fiber, to utilize which in smokeless powder huge Southern plants were built, is now available for paper making and other arts of peace. The products and the potentialities of the cottonseed now have a rival in the humble peanut, and in at least one Southern locality the peanut crop exceeds the cotton crop in value. In the South as a whole the value of the corn crop already approximately equals that of cotton and affords a basis for great corn product industries. To such material resources, with many others, to which no reference can here be made, the South adds the potentialities of 5,000,000 hp. in the available energy of her streams.

SOME GREAT SOUTHERN PLANTS

The South is no stranger to chemical developments on a great scale. The largest electrolytic copper plant in the world refines 720,000,000 lb. a year at Canton, Maryland; Ducktown, Tennessee, produces 1000 tons of sulphuric acid a day. The war called forth in Sheffield, Alabama, nitrate plants designed for a carbide production equal to that of the entire continent and for 100,000 tons of ammonium nitrate yearly. The Old Hickory plant at Nashville had an estimated cost of $90,000,000 and in nine powder lines, each of a capacity of 100,000 lb. a day, took the raw crude cotton and, producing both the acids and the solvents used, turned out the finished powder. The plant at Nitro, West Virginia, was designed for 625,000 lb. a day of powder. To the South must also be credited the great plant of the du Ponts at Hopewell.

These industrial achievements, stupendous though they are, derive their chief significance as evidence and measures of what will be accomplished in the South when capital joins hands with chemistry in the coordinated development of Southern resources.

J. W. Richards wisely and truly says, "The industries are fundamentally based on the imagination." Those who would share in this great development must mix imagination with statistics and have the courage to accept their findings and the initiative to act on them. What then may chemistry be reasonably expected to accomplish in the South? And how?

SOUTHERN FERTILIZER INDUSTRY

With increasing density of population in the South and throughout the country a more intensive agriculture must everywhere be practiced. A great expansion of the Southern fertilizer industry, already so important, would seem to be assured. Improved methods of production will check the abnormal wastes which now accompany the mining of phosphate rock, raise the intrinsic value of the product and permit of larger profits. The potash content of the gray iron ores of Alabama will be rendered available and supplied to agriculture as a by-product of the blast-furnace. From the expanding portland cement industry more by-product potash will be similarly derived. Ammonia from by-product coke ovens will be recovered in vastly greater quantities. Some extension of cyanamide production may be expected, but the vast stores of cheap nitrates and ammonia which the new agriculture will demand will come from the atmosphere by direct nitrogen fixation.

SOUTHERN WATER POWER INDUSTRY

Southern water powers will play an important although not necessarily a controlling part in their development. In the best interests of the South, it is in any case desirable that they be not linked up too exclusively to electrochemical processes, since these create relatively little opportunity for labor. It is incomparably more advantageous to constitute the water powers the centers of diversified and highly developed manufactures, the economic value of which may be a hundred times that of the water powers themselves.

It is probable, nevertheless, that for a generation or two at least Southern water powers are to find their chief applications in the field of electrochemistry, which is already extensive enough to insure a considerable diversity of industry. More and more will the electric furnace become a factor in the steel industry in the smelting of steel itself and in the production of ferro-alloys, of non-ferrous alloys, abrasives, carbide and other products now unknown. Methods of electrolysis will utilize much hydro-electric energy in making chlorine and alkali, chlorates, peroxides, perborates and persulphates.

The extraction of aluminum from bauxite is at last well established as a Southern industry at Maryville, Tennessee. In Alabama are great beds of bauxite only seventy miles from water power and with rich seams of coal between. But the production of aluminum is destined to be far more closely identified with the South. Ultimately will come effective and economical methods for the direct extraction of the metal from clay. Then each of the immense deposits of kaolin in Virginia, the Carolinas, Georgia, Florida and Alabama will be reconstituted as mines of aluminum ore.

SOUTHERN CLAYS AND FUELS

The variety and range of character exhibited by Southern clays is amply sufficient to meet every requirement of the ceramic industries from bricks, tiles and terra cotta through pottery to porcelain. In many instances, the finer sorts have had their usefulness restricted by the presence of titanium minerals in small proportions. Here again chemistry has played its part by demonstrating a simple and inexpensive method for the removal of these impurities, with the result that the purified clays are suitable for the finest chinaware and porcelain. In the pegmatic dikes of the Appalachian region are great deposits of very pure quartz awaiting the enterprise of the glass maker.

Our present methods of utilizing coal are wasteful in the extreme. To set free its energy values we commonly employ means which wholly ignore its far greater chemical values. Moreover, bituminous coal, which constitutes the bulk of our supply, is not a desirable fuel for use in cities and our supply of anthracite is down to 190 tons per capita. Our railroads are breaking down under the strain already put upon them as transportation agencies and about one-third of their tonnage is coal. All this points to a radical readjustment of our use of coal and to a readjustment which should enormously benefit the South. It means that coal must be burned much nearer to the mine in super-power plants and its energy delivered to great common carrier transmission lines for power linked to hydro-electric developments and operated in co-ordination with them. It also means huge gas works in which the chemical values of the coal are saved as ammonia and tar, the coke converted into artificial anthracite and the gas made available for distribution for light, and heat and power over wide areas. There will follow as a consequence a corresponding development of the higher industries based upon the chemical values thus conserved, and producing dyes, intermediates, synthetic drugs and new types of coal-tar products. Lignite and peat will ultimately be involved in these comprehensive plans and yield their enormous quota of gas, ammonia and briquets.

NATURAL GAS AND OIL

Natural gas, of which the South now yields 80 per cent of the country's whole supply, has not only been wasted shamelessly but was long regarded merely as a cheap and convenient fuel. We are now coming to realize that it has values and potentialities far beyond those of the thermal units it contains. Hundreds of plants now extract gasoline at the casing head, and the gas itself is recognized as a raw material available for many organic syntheses, as for example chloroform. Certain wells, notably those of Petrolia, Texas, have assumed an altogether new importance as sources of helium, urgently required for airships because of its high lifting power, non-inflammability, and low rate of dispersion through balloon fabrics.

Friction will bring the industries of the world to a standstill unless they are provided with a continuous and assured supply of lubricants, and these are practically all derived from petroleum. The impending exhaustion of the petroleum fields of the South is thus a matter of deep concern wherever wheels turn or machinery functions. The rapidly increasing and already extensive use of fuel oil is therefore an economic blunder which one day may be characterized as worse than a crime. Such oil as remains should be conserved until with incomparably greater benefit to the South due provision is made for utilizing its higher values in the production of lubricants, dyes and intermediates and the synthesis of gasoline by methods which Rittman, Cherry and other chemists have already indicated. It is important to remember that the asphaltic oils of the South are more reactive and therefore much more generally available for the higher syntheses than the oils of Pennsylvania, which have a paraffine base.

SOUTHERN METALLURGY

The wet methods of metallurgy as exemplified in the cyanide and chlorination processes have upset the economic balance of the world through the inordinate increase in gold production due to them. It may be regarded as certain that other wet methods will be developed, and it may easily be soon, which will render possible the profitable working of the great beds of low-grade ores of various metals existing in the South, as for instance, the nickel ores of Georgia or the low-grade zinc ores of Missouri.

IRON AND STEEL INDUSTRY IN THE SOUTH

It needs no prophet to point out the inevitable vast extension in the South of the iron and steel industry already firmly established on a great scale. Around it will naturally evolve groups of associated and dependent manufactures—potash and slag cement; chemically pure iron and special alloys; plants for working up the by-products of the coke oven; new foundries and plate and wire mills and all the multitudinous activities based on steel and controlled by chemistry.

The basic chemical products, sulphuric acid, soda, bleaching powder and others known collectively as heavy chemicals, require for their manufacture sulphur, salt and limestone. Nowhere are these essentials available more profusely than in Louisiana, and the potentialities of their concurrence are magnified by their proximity to the great Caddo gas field, the oil of Texas and Louisiana and the cheap coal of Alabama.

ROSIN AND TURPENTINE

The world now depends chiefly upon the South for its supply of rosin and of turpentine, both relatively crude products and for the most part crudely used. Yet rosin is the cheapest organic acid available to chemistry and should be made to yield products of higher value and wider range of use. Turpentine is also the cheapest volatile oil and clearly indicated as the logical starting point for many syntheses. It is already the raw material for synthetic camphor, and camphor is worth $3 a pound.

The end of the virgin supply of crude turpentine is already in sight and much nearer than is generally realized. Fortunately for the South and for the world, chemistry has performed the double service of demonstrating that cut-over lands may profitably be cleared and new supplies of rosin, turpentine and pine oil extracted from the encumbering stumps of long-past lumbering. Even from the spent chips of the extraction plant, excellent Kraft paper has been made.

BRIGHT PROSPECTS FOR THE SOUTH

In the future, the South must look for much of its prosperity to the utilization of present wastes. They are colossal in the lumber industry, in gas and oil and agriculture. A ton of straw, for example, will yield 11,000 ft. of gas or 800 lb. of high-grade paper. Great stores of ethyl alcohol, rosin, turpentine, gas and tar and many thousand tons of paper, container and building boards, fruit wrappers, bags and twine are potentially present in the wood waste burned in the South each day.

The high price of pulp wood has arrested the development of paper making in the North and for the next decade at least the expansion of the industry will be in the South, which offers the cheapest pulp wood on the continent outside of Alaska, and which offers also, in close association thereto, the raw materials required for its production.

To insure these benefits the South needs, as recently pointed out by Coates, the creation of an atmosphere in which the spirit of manufacturing enterprise may develop freely. It still lacks an adequate number of industrial leaders. It needs far more chemists and should place far more trust in those it has. It needs research and more research.

Plans for Manufactures Census Completed

SPECIAL effort is being put forth to make the manufacturers section of the approaching Fourteenth Decennial Census the most complete and comprehensive inventory of the nation's manufacturing establishments ever taken, according to officials of the United States Bureau of the Census who have this work in charge.

The schedules which will be used in tabulating the information about the country's industrial resources have already been prepared and printed. These schedules will be mailed to every manufacturing establishment in the United States during December, so that factory owners and managers shall be in a position to familiarize themselves in advance with the questions which are to be answered when the records of the past year's business have been compiled. The questions relate to the calendar year 1919.

LAST CENSUS IN 1914

In 1914, the year the last manufactures census was taken, about 275,000 manufacturing establishments were listed by the Census Bureau. This time more than 300,000 establishments will be sent schedules. In addition to this it is expected that about 50,000 mines and quarries will also be reported.

The inquiries relating to manufactures, as specified by the act of Congress providing for the census, include the name and location of each manufacturing establishment; character of organization, whether individual, corporate or other form; character of business or kind of goods manufactured; amount of capital actually invested; number of proprietors, firm members, copartners and officers, together with the amount of their salaries; number of employees and amount of their wages; quantity and cost of materials used in each establishment; quantity and value of products; principal miscellaneous expenses; time in operation during the year; character and quality of power used; and character and number of machines employed.

The questions as outlined above will be covered by the general schedule which every establishment will receive. In addition to this a supplemental schedule will be sent to the 68 principal industries as classified by the Census Bureau. This supplement schedule, it is expected, will allow detailed statistics of output to be collected and set forth under the heading "products manufactured."

The census of manufactures is limited to manufacturing establishments with an annual product of at least $500 conducted under what is known as the factory system, exclusive of the so-called neighborhood, household and hand industries. However, no establishment is too small to be counted by the Government if it comes within the definition of a manufacturing establishment.

INFORMATION TO BE CONFIDENTIAL

Census Bureau officials emphasize the fact that all information gathered by the census is strictly confidential, made so by act of Congress, and is for general statistical purposes only. The same is true of the censuses of population, agriculture, mines and quarries, oil and gas wells and forestry and forest products.

Many startling figures are expected to be shown by the approaching compilation, inasmuch as the industries of the country were for the most part in a subnormal condition in 1914, the year the last manufactures census was taken.

Pure Gum Shellac

Origin of Sticklac—Entomology of the Tachardia Lacca—Crops—Manufacture of Native and Machine Grades—Makers' Marks and Chemical Analyses—Specifications for Pure Shellac Varnishes Based on Experience With Impurities Encountered in Manufacturing Processes

By CHESTER H. JONES

THE continued and increasing use of shellac in the arts and industries and recent requirements for a pure neutral varnish to resist the action of various chemicals and electric pressures have awakened an interest in the circumstances surrounding the origin and method of production of the gum, with especial reference to the possible impurities which may enter into the processes employed in obtaining the commercial grades. Investigation has shown that a surprisingly large percentage of the better informed persons, and even chemists, who are familiar with this everyday substance as an ordinary varnish, have little or no knowledge of its origin and no information for use in distinguishing its value as compared with other varnishes. There is also little information available on the percentages, kinds and effects of impurities entering into the analysis of the different types or marks.

Many thousands of years ago in the mystic and interesting land of India it is recorded in the Sanskrit literature that the aboriginal tribes, seeking a coloring matter for their ornaments and clothing, found a resinous incrustation on the twigs of the Lakhsataru, or lac-tree, and by simple extraction in water secured a red dye known as lac-dye. This had been a standard article of commerce and chief competitor of cochineal up to the advent of synthetic dyes, but is now entirely discarded in the washing processes. The decrease in the use of the dye began in 1868 and was stopped entirely about 1900.

The value of the lac-resin as a varnish was discovered many centuries later, when probably its first use was the melting up and casting into beads, amulets and other native ornaments. The earliest record as an applied coating to woodwork was noted by Akbar in the Ain-i-Akbari in 1590. In 1596 a Dutch explorer describes its use in a European publication, but evidently was without knowledge of its origin.

ORIGIN OF STICKLAC

The lac resin from which shellac is derived is made by an insect known as the Tachardia lacca, and its product, found as an incrustation on the smaller twigs of several types of tree, is broken off with the supporting twig, giving the sticklac of commerce. The specimen shown on the right-hand side of Fig. 1 is a branch of the dhak tree well covered with a fully developed incrustation.

The insects swarm twice each year, much as the bee, with about 5 per cent of the swarm consisting of males. Being gregariously inclined, they alight in densely packed masses on the twigs of the tree, as shown on the left hand figure in Fig. 1. An enlarged view of the top of the same twig is shown in Fig. 2.

As soon as the larva alights it buries its beak through the bark into the tender part of the tree, and inserting a sucking tube, proceeds to withdraw the sap. After absorption of some of the constituents of the sap and modification of others within the body, it excretes a fluid at the anal end. This excretion forms a covering over the insect and, slowly hardening on contact with the air, a cell is produced. As these cells are very close together, the whole coalesces and takes the form of a crust.

ENTOMOLOGY OF THE TACHARDIA LACCA

This insect being a most noteworthy little chemical factory in itself, and with habits and troubles which affect greatly the market quotations for its product, brief reference to the entomology should be of value.

The bug belongs to the order known as plant lice, or scale insects, whose habits are to suck the sap of plants with the proboscis, and to that particular group in the family which covers the body with an excretion. The original purpose of this performance was to protect from predacious enemies while attached to the plant.

The newly hatched insect is red or orange colored and very small. Fig. 3, right hand figure, shows first instar, active stage, magnified 40 times. Actual length of body is about $\frac{1}{40}$ in. At the end of the first month the female has built a cell around herself as shown in left-hand side of Fig. 3, and is about 1/18 in. in length.

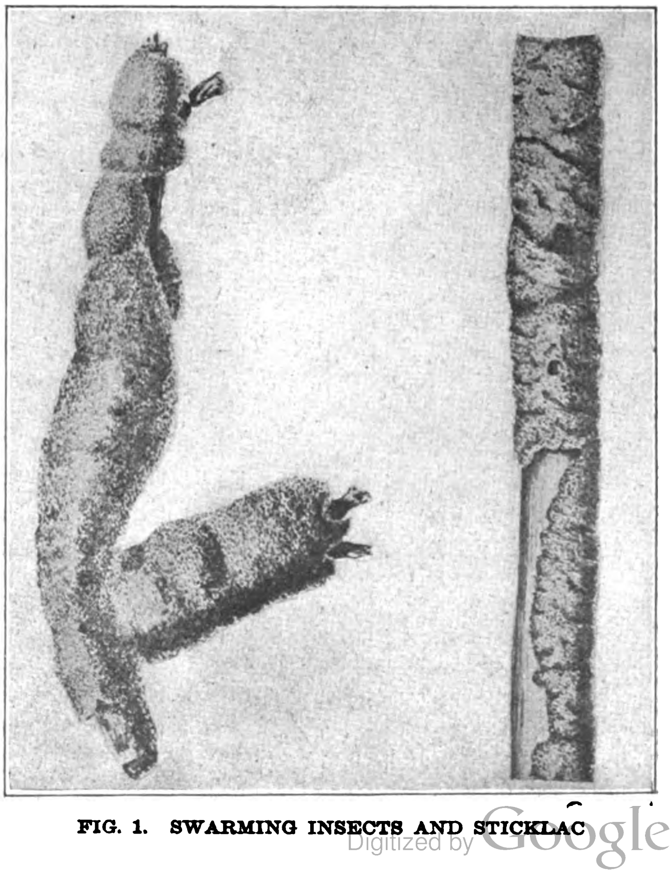


FIG. 1. SWARMING INSECTS AND STICKLAC

The body has turned dark red and the appendages have nearly disappeared.

When about two and one-half months old the female is impregnated by the male and continues to grow and exude lac for another two and one-half months. The ovary becomes so enlarged as to occupy nearly the whole body and is filled with a bright red fluid. This is the basis of the lac-dye. From this fluid the eggs form during the sixth month. The female has ceased feeding.

The lower right hand figure in Fig. 4 shows the female cell thirteen weeks after inoculation and the upper left hand figure shows the dead female cell with young emerging. This last, then, is a single cell nearly ready to harvest for sticklac.

The male insect after a short period of activity also comes to rest on a twig and forms a cell. There are two varieties of males as shown in Fig. 4. At the end of the sixth month the swarming shown in Figs. 1 and 2 occurs, and the crop is ready for the gathering.

Crops of Sticklac

India is the source of all shellac for the world markets, and the bulk of the sticklac is harvested there. Some of the latter, however, comes from the Malay Peninsula and Siam to Calcutta factories.

There are four crops gathered each year. The "Bysackie" crop is gathered in April in the Sind, Punjab, Bundelkand Bengal and Birbhum, reaching the factories in May and June. This is the principal crop of the year supplying the T N (truly native) grade.

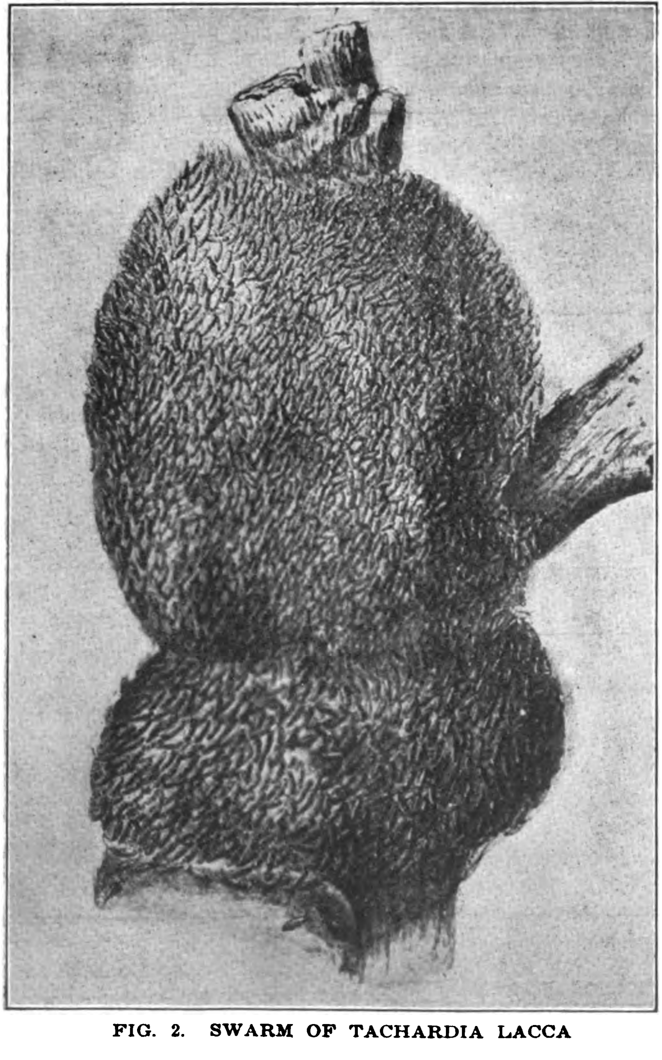


FIG. 2. SWARM OF TACHARDIA LACCA

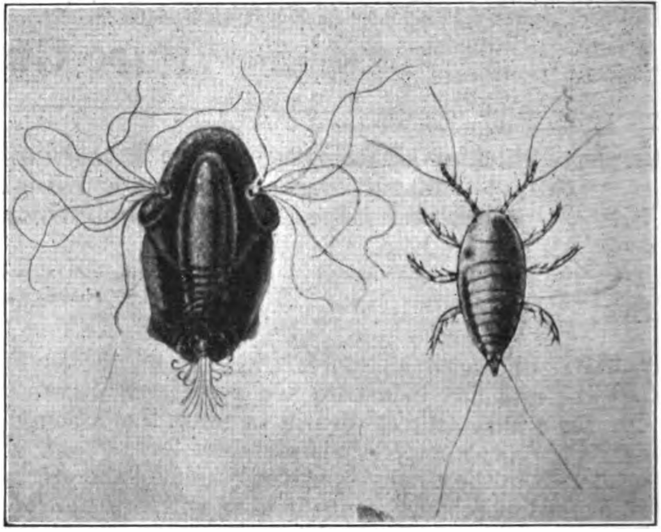


FIG. 3. RIGHT—FIRST INSTAR MAGNIFIED 40 TIMES. LEFT—FEMALE ONE MONTH AFTER INOCULATION, 25 TIMES ENLARGED

The "Jetowa" is gathered in August and September in Birbhum and Upper Burma. It is of fine quality and is used largely in seeding. The "Rungeen" crop is harvested in October and November in Sind, Punjab, Bundelkand Palamau, Birbhum, Assam and Upper Burma. There are said to be three crops per year in Burma.

The "Koosmi" crop, gathered in November and December, furnishes the finer grades. The quantities produced at each harvest in terms of finished shellac are approximately as follows:

	Lb.
Bysackie crop	50,000,000
Jetowa crop	1,300,000
Rungeen crop	3,600,000
Koosmi crop	11,500,000

Forestry

Each province or locality produces its own particular quality and kind of sticklac, which is determined very largely by the variety of tree on which the insect feeds. There are 88 varieties of lac-yielding trees, the most important of which are:

Butea frondosa (palas or dhak)
Cajanus indicus
Ficis bengalensis
Ficis religiosa
Ficis rumphii
Schleichera trijuga
Zizyphus jujuba

The preservation and cultivation of these trees to prevent entire destruction from the drain which they undergo during feeding of the lac insect and destruction of other agencies are carried on by the Indian Government. The Conservator of Forests, in charge of this work, also is responsible for keeping down the insects which prey upon the Tachardia lacca, and the promotion of the lac industry in general.

Manufacture and Refining

The raw material, consisting of sticklac and grainlac, is sold on the ground to middlemen who take it to the factories. Grainlac consists of incrustations broken from the twigs by wooden mallets, leaving the twigs on the trees. Fig. 6 shows the crop being harvested, dried and collected.

There are two methods of manufacture, namely, hand, or native, and machine method. The native process of refining is much the same as has been employed in India for many centuries, and a large percentage of the market is supplied by native goods.

NATIVE MANUFACTURE

Upon arrival at the factory the sticklac or grainlac is ground in hand-operated mortars to remove from the sticks and to such a mesh as requires that the individual cells be broken open to free the remains of the inclosed insect. It is then sifted through a hand sieve. These operations are shown in Fig. 7. The products are here separated into three classes: (1) Granular lac, known by the trade name of seedlac; (2) fragments of branches and twigs, which are often used as fuel; and (3) fine dust, which consists of small fragments of lac and dirt known as Khud, which is sold to makers of trinkets and toys.

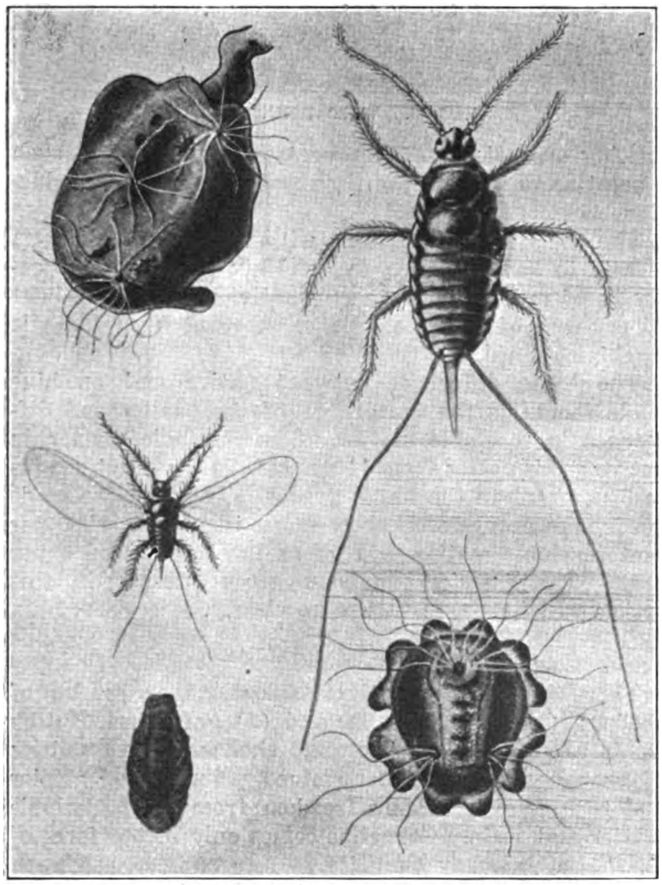


FIG. 4. FROM LEFT TO RIGHT—DEAD FEMALE CELL WITH YOUNG EMERGING, 4 TIMES ENLARGED. WINGLESS MALE, 12 TIMES ENLARGED. WINGED MALE, 40 TIMES ENLARGED. MALE CELL, 15 TIMES ENLARGED. FEMALE CELL 13 WEEKS AFTER INOCULATION, 15 TIMES ENLARGED

The seedlac is next washed, undergoing a soaking for about twenty-four hours, and is again ground to insure the breaking up of individual cells. It is desirable to wash out thoroughly the included organic matter. The wash water takes on a deep purple color due to the dye. A residue of dirt and fine lac is recovered from the wash water and sold to native bangle makers under the name of Gand. The washing process is shown in Fig. 8. After washing, the seedlac is exposed to light and air on drying floors, where it bleaches to some extent.

There are several variations of this method where lac is prepared for local consumption in the distant provinces away from the factories. In the Punjab the lac is boiled in a solution of crude sodium carbonate and borax, or rubbed in water with alum, and strained through a cloth, repeating until all the dye is removed.

In some cases, as in Hyderabad, the grainlac is mixed with potash, dry, and bleached in the sun. All the methods have the one object, that of removing the red dye.

Where adulterants are to be employed they enter the process at this point. Orpiment (As_2S_3) or rosin (imported from North Carolina), or sometimes both, are mixed with the seedlac. The orpiment is used to impart a rich pale straw color to grades where a light color is required. The garnetlac and other darker grades will usually be free from this arsenic adulteration.

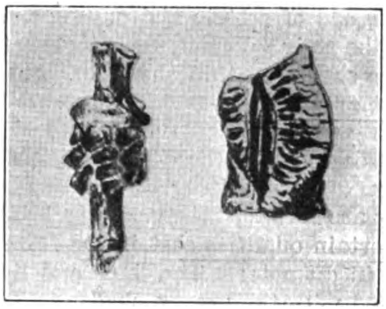


FIG. 5. LEFT—TRANSVERSE SECTION OF FEMALE LAC CELLS. RIGHT—LONGITUDINAL SECTION OF SAME

Rosin is added to lower the melting point of the seedlac so necessary in the next step of the process, and a certain amount is recognized as being necessary in the native operation. Rosin, however, in quantities, causes cracking and flaking in the final varnishes. The resiliency, or bending quality, is one of the valuable physical characteristics of pure shellac.

It is the practice of unscrupulous makers to add rosin in proportions as high as 20 per cent during high markets. Specifications should demand rosin content of less than 3 per cent for native commercial grades.

FIG. 6. HARVESTING STICKLAC

The mixture of seedlac and adulterant is placed in cloth bags about 12 ft. long and 2 in. in diameter. These bags are held before open furnaces heated by coke and charcoal fires, with a native at each end of a bag. Fig. 9 shows a view of the fireplace and Fig. 10 the melting and stretching operation.

As the contents of the bag begin to soften in the portion directly before the fire, the bag is twisted, squeezing the melted material through the mesh. Occasionally a reverse twist is given to one end of the bag, causing an emptied portion to coil up. The bag is drawn steadily forward until all portions have been before the fire and the contents exhausted.

The melted lac drips to the floor. Any portions not sufficiently melted are recovered and remelted. The warm and partly molten lac is picked up by a third native, who stretches it into thin sheets by placing a foot on either end of a strip and pulling the center upward before the body. Variations of this action eventually bring the shellac to thin sheets or flakes, the form seen on the market.

The sheets are examined and sorted as shown in Fig. 11. All dark-colored or dirty portions are broken off and returned for remelting. Parts not bleached and of a red color are sorted as the garnetlac. Button lac is made from certain qualities cast in the form of buttons about 1½ in. in diameter. The finer and lighter qualities are graded with the orange shellacs. They contain the greater percentages of the adulterants.

After the bags are empty they are boiled to remove the residue, known as Kiri or Phog, from which inferior shellacs are made. These are cast in slabs about 6 in. in diameter and 1 in. thick and sold to makers of bangles, sealing wax and similar articles.

MACHINE PROCESSES

The aboriginal method of manufacture has been much improved upon in recent years by the machine methods. These are employed by only one firm, as far as we know, however, and have not displaced the native methods of other makers because of the secrecy surrounding the design of machinery.

The sticklac and grainlac are fed to mechanical grinders, and steam enters largely into the washing and melting operations. The processes are refined to such a point as to shorten the time and increase the production enormously.

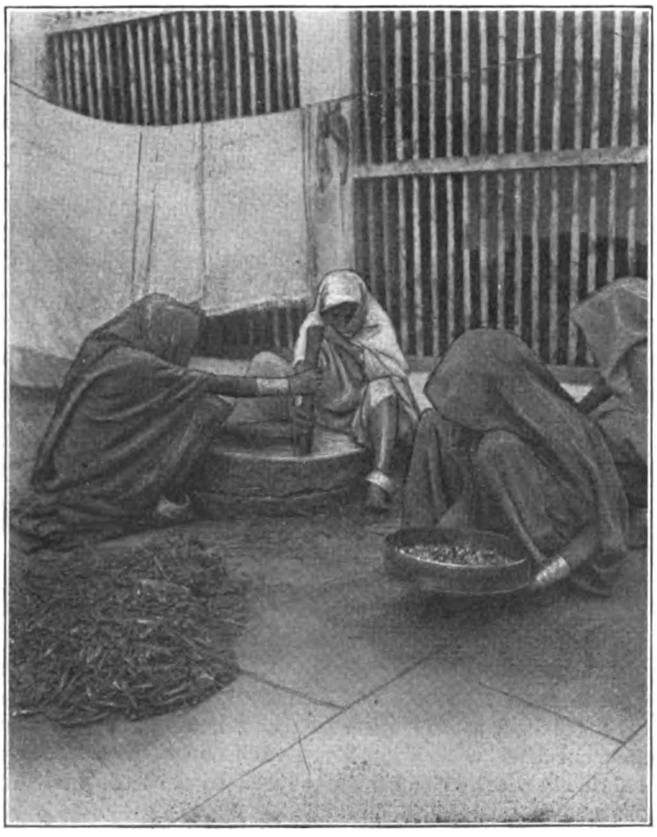


FIG. 7. GRINDING AND SIEVING

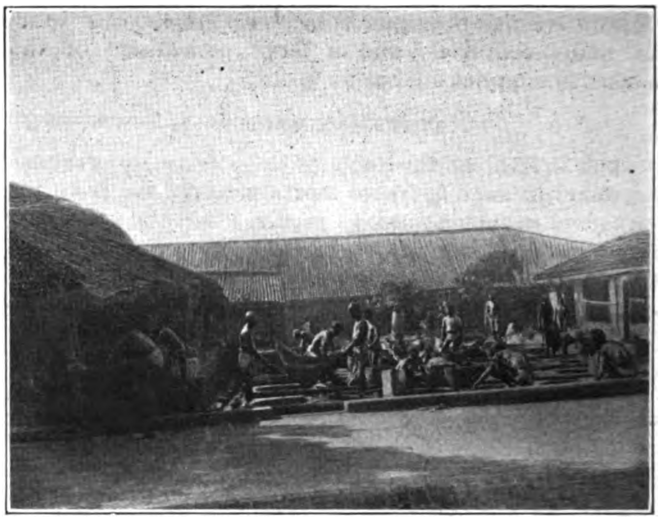


FIG. 8. WET REFINING

The one European concern with factories in Calcutta is said to have between five and six times greater capacity of production than any native producer. About 10 per cent of the total shellac exported from India is machine refined.

The basic difference between native and machine made shellac is the uniformity of the quality and difference in insoluble matter. The insoluble matter in native goods varies from 1½ per cent in the finest grades to 5 per cent in the lower grades. The machine made goods, however, never show more than 0.50 of 1 per cent insoluble matter and go as low as 0.20 of 1 per cent. The chemical analyses given further in this article will illustrate this more clearly.

GRADES OF SHELLACS

There are two general classifications or grades of shellac: (1) Orange shellac and (2) garnetlac. Button lac is a sub-division of orange shellac. The qualities of orange shellac are determined principally by color and to a less degree by freedom from dirt, insoluble matter and rosin. Garnetlac comes only in the form of flakes, but in many qualities.

The popular native marks of shellacs in the order of their value and quality are as follows:

D C
V S O
Diamond I
Double Triangle G
Superior
Superfine
Fine
Good
T N (Truly Native)

These are all orange shellacs. The first four are called standard marks, each made by a separate native manufacturer.

The terms Superior, Superfine and Fine are simply descriptive, and in order named range from light to less light qualities down to T N, which is the lowest and darkest grade.

There are corresponding grades of machine-made shellacs. Of these grades, which are given under trade names of the maker,[1] the garnetlac is the superior grade where highest content of lac resin is required, regardless of lac, wax and color.

---

[1] Angelo Bros., Calcutta, India.

CHEMICAL ANALYSES

Shellac consists of lac resin itself, which is the gum shellac; a certain amount of so-called lac wax, a hard whitish or brownish substance more like carnauba wax than any other; a small percentage of moisture and the insoluble matter, which is, speaking generally, either organic matter, the remains of the lac insects, and so-called residue of vegetable, mineral or other substances. Average analyses of high-grade native hand-made goods run about as follows:

	Per Cent
Lac resin	93 to 94
Lac wax	3 to 4½
Moisture	1½ to 2
Insoluble matter, of which the organic matter is usually two-thirds	1 to 2

Low-grade native hand-made shellacs analyze about as follows:

	Per Cent
Lac resin	91 to 93
Lac wax	3½ to 4½
Moisture	1½ to 2½
Insoluble matter, of which the organic matter is usually two-thirds	2½ to 4 or even 5

The average analyses of machine-made shellacs vary only slightly and run about as follows:

ORANGE SHELLAC

	Per Cent
Lac resin	95 to 96
Lac wax	3 to 4
Moisture	1½ to 1.6
Insoluble matter	0.2 to 0.3

GARNETLAC

	Per Cent
Lac resin	97.7
Lac wax	0.5
Moisture	1½ to 1.6
Insoluble matter	0.2 to 0.3

It is of course understood that the shellacs above mentioned are free from rosin. If rosin is added, cut down the percentage of lac resin in exact percentage to the amount of rosin.

The analyses of a large number of samples of crude lacs by Dr. D. Hooper for the Indian Forest Service have been averaged into the following table:

Name of Tree	Water	Resins	Coloring Matter	Residue	Ash
Kusum (Schleichera trijuga)	1.8	85.6	2.5	9.1	1.0
Ficus	1.8	83.9	2.6	10.2	1.5
Ber (Zizyphus jujuba)	2.0	82.7	2.4	11.5	1.3
Palas (Butea frondosa)	2.4	77.4	4.3	14.1	1.8

CHEMICAL COMPOSITION OF SHELLAC

Analysis of commercial D C shellac made by H. Endemann shows on treating with a caustic alkali solution a residual wax having a carbon content of 82.18 per cent and hydrogen 14.25 per cent. A complete analysis of the above gave the following:

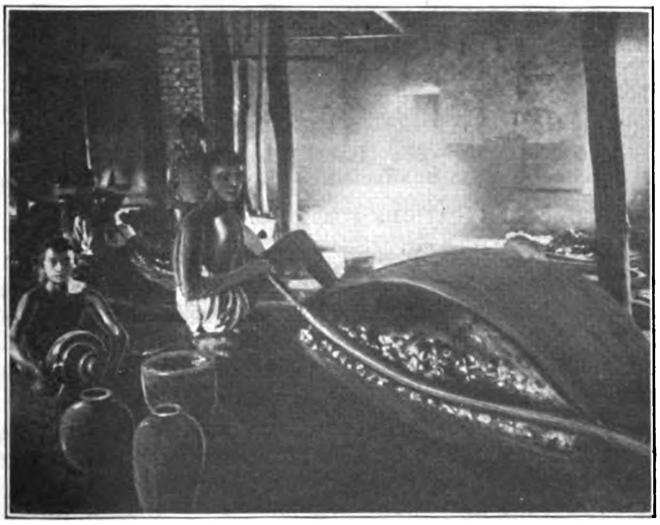


FIG. 9. FIREPLACE

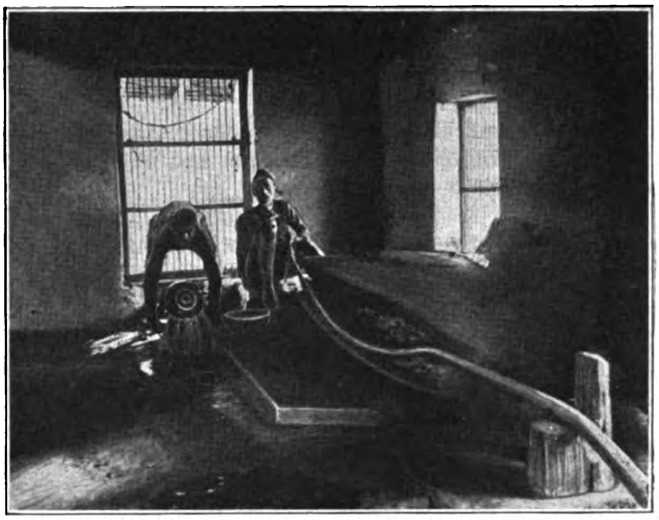


FIG. 10. MELTING AND STRETCHING

4.5 per cent myricyl alcohol.
8.0 per cent non-condensable acids (not oxyacid) and impurities
27.0 per cent soluble and crystallizable oxyacid.
60.5 per cent oily oxyacid, only slightly soluble.

PURE SHELLAC

Dry shellac for use in coatings in the United States Navy has been purchased for a long period of time on the following general specifications:

ORANGE GUM SHELLAC

Grade A Quality.—1. *For pattern and varnish work.* To be of a grade similar in quality to the brand known commercially as "Double Triangle G," and must be freeable by hand without the use of any tools. When treated with hot 95 per cent alcohol, the residue of insoluble matter must not exceed 1¾ per cent and the shellac must be free from rosin and other adulterants. All deliveries must be equal in color and in all other essential respects to the standard sample of this grade of shellac.

Grade B Quality.—2. *For coating linoleum-covered decks.* To be of good quality and must be freeable by hand without the use of any tools. When treated with 95 per cent hot alcohol, the residue of insoluble matter must not exceed 3 per cent. It must be of one of the following two qualities: (1) Free from rosin and have an iodine number of less than 18 as determined by method of subcommittee on shellac analysis (*Journal* of the American Chemical Society, pp. 1221 and 1227, Vol. 29, No. 8, August, 1907); or (2), the grade known commercially as "U. S. S. A. Standard T N," containing not more than 3 per cent rosin. The grade of shellac known as "New York Standard 3 per cent" will not be accepted. Deliveries of rosin-free shellac and "U. S. S. A. Standard T N" must in all essential respects be equal to their respective standard samples of these grades.

Grade C Quality—Garnetlac.—3. *Garnetlac for coating linoleum-covered decks.* To be of good quality and ground fine enough to be readily soluble in alcohol. When treated with 95 per cent hot alcohol the residue of insoluble matter must not exceed 1 per cent. To be free from rosin and have an iodine number of less than

18, as determined by method of subcommittee on shellac analysis, referred to above. All deliveries must be equal in all essential respects to the standard sample of this grade of shellac.

These specifications probably cover the situation where a coating of good mechanical and physical properties is desired.

NEARLY CHEMICALLY PURE SHELLAC

If a covering is required where the shellac is to be subjected to electrical stresses or certain chemicals, and for special mechanical uses where flexibility is a feature, the specifications must be somewhat different.

During the period just past it became necessary to draw up specifications for shellac with which the interior of explosive shells might be coated to resist the action of new explosive chemicals on the steel body and to present a smooth tough surface which would cause little friction when the shell was whirling through the air, in case the cast charge became loosened in its container. In case of failure either the chemical action or the friction of charge against steel might cause premature explosion of the shell.

The first procedure was to send a number of samples of mixed varnish to the laboratory from a selection that had been passed on by commercial chemists as being satisfactory for the purpose. Results from two of these analyses were as follows:

SAMPLE MARKED "No. 1"

Acidity................	Shows distinct acid test within a minute.
Ash..................	0.6 per cent. Contains manganese, zinc, iron, aluminum, calcium.
Flash point...........	Below 20 deg. C.
Action of picric acid...	No action after 5 days' contact.
Time of drying........	Fifteen minutes.
Covering quality......	Covers well but dries too quickly for satisfactory brushing.
Hardness and adherence,	Coating brittle, adherence poor. Does not pass the knife or hammer test.
Bending test..........	Cracks and flakes badly upon bending.

This sample does not comply with tentative specifications for interior shell coatings because of the poor adherence on steel, and presence of objectionable metals. Also on account of failure to pass acidity test.

SAMPLE MARKED "No. 3"

Acidity..................	Distinct acid test within one minute.
Ash.....................	0.3 per cent. Contains zinc, calcium, aluminum, iron (trace).
Flash point.............	Below room temperature (70 deg. F.)
Action of picric acid......	No action after 5 days' contact.
Time of drying..........	Ten to fifteen minutes.
Covering quality........	Covers well, but dries too quickly for satisfactory brushing.
Hardness and adherence...	Coating brittle, adherence poor. Does not pass knife or hammer test.
Bending test............	Cracks and flakes badly.

This sample does not comply with tentative specifications for interior shell coatings, because of poor adherence on steel and presence of objectionable metals. Also on account of failure to pass acidity test.

The results of these tests show without doubt that the samples were of the usual mixed varnish type heavily loaded with rosin and of a poor grade of shellac.

METHOD OF TESTING

Shellac varnish analyses are rather difficult to run for impurities and chemical properties, so it was decided to test the ingredients for purity before mixing in the varnish and then try out for performance under as near service conditions as possible. The following procedure was followed with a number of samples with the purpose of ascertaining the reaction of various explosives upon shell protective coatings and the analysis of them to ascertain if they are true to name, and contain no undesirable metallic elements.

The explosives used were:

TNT
E L 104 (du Pont)
Nitro starch (du Pont)
Amatol (80-20) Picatinny Arsenal)
Amatol (50-50)
Sodatol (80-20)
Ammonal
Picric acid
Ammonium nitrate

Experimental shells were made by machining one-inch pipe caps until the inside was bright and smooth and then coating the interior with the lacquer to be tested, some by brushing, and others by pouring in the lacquer, turning cap around to insure complete coating, and then inverting to permit the excess of lacquer to run out. (This gave a heavy coating.)

FIG. 11. INSPECTING SHELLAC

The caps were loaded reasonably full of the various explosives and put in an oven at 50 deg. C. for one week. At the end of the period they were unloaded and the condition of the film in the cap interiors was carefully noted. Results are shown with one sample as follows:

TNT—Film glossy, good condition.
E L 104—Film glossy, good condition.
Nitro starch—Film glossy, good condition.
Amatol, 80-20—Film glossy, good condition.
Amatol, 50-50—Film glossy, good condition.
Sodatal—Film glossy, good condition.
Ammonal—Film glossy, good condition.
Picric acid—Film glossy, good condition.
Ammonium nitrate—Film glossy, good condition.

Hot loading—thick film (poured):

TNT—Sweat out at upper edge of cup. Film unaffected.

Picric acid—The P.A. binds tightly to the lacquer. Film unaffected.

FINAL SPECIFICATIONS FOR PURE SHELLAC VARNISH

After investigation and research extending over a period of several months a specification was prepared, and it is believed that use of the abstract of this, given below, will secure the purest shellac varnish commercially obtainable. Special applications must always be considered.

Varnish to be entirely free from alkali, mineral acids or volatile organic acids. Test to be made by thoroughly shaking approximately 20 grams of sample with 50 cc. of neutral distilled water, continuously for ten minutes. Then test with neutral litmus paper. If no change occurs in three minutes the amount of acid or alkali is negligible. If either acid or alkaline reaction occurs the varnish will not be accepted.

Varnish to be entirely free from heavy metallic oxides for driers or any other purpose, except traces of iron oxide, lime or silica.

Varnish shall contain no nitrocellulose or any nitrated material.

Varnish must adhere firmly and when dry shall present a *heavy*, firm, tough, glossy coating which will not crack, peel or flake.

Varnish shall be mixed as follows:

Shellac	4 lb., 1 oz.
Alcohol	1 gal.
Turpentine	1/20 gal.

Shellac or garnetlac, used in the above formula, shall conform to the following specifications:

> To be good quality and ground fine enough to be readily soluble in alcohol.
>
> When treated with 95 per cent hot alcohol, or tested in an alcohol insoluble apparatus for shellac, the residue of insoluble matter shall not exceed 1.75 per cent.
>
> Must be free from rosin and have an iodine number not more than 18, as determined by method of subcommittee on shellac analysis (*Journal* of the American Chemical Society, pp. 1221 and 1227, Vol. 29, No. 8, August, 1907).
>
> Moisture must not exceed 1.75 per cent.
>
> Ash must not exceed 1.5 per cent.
>
> May be *any* color.

Alcohol, used in above formula, must be either 188 proof completely denatured or 190 proof specially denatured.

Turpentine, used in above formula, to conform to following specifications:

> Quality—The turpentine shall be (1) either a properly prepared distillate from pine oleo-rosins, commonly known as gum turpentine or spirits of turpentine; or (2) that obtained from resinous wood by extraction with volatile solvents, by steam, or by destructive distillation, and commonly known as wood turpentine.
>
> The turpentine shall be clear and free from suspended matter or water.
>
> The color shall be water white.
>
> The specific gravity shall not be less than 0.860 or more than 0.875 at 15.5 deg. C.
>
> The initial boiling point shall not be less than 150 deg. C. or more than 160 deg. C.
>
> Ninety (90) per cent of the turpentine shall distill below 170 deg. C.
>
> The polymerization residue shall not exceed 2 per cent and its refractive index at 15.5 deg. C. shall not be less than 1.500.

Tests. Tests of ingredients shall be made by an inspector before mixing to form varnish, and the mixing of approved materials shall be witnessed by the inspector. The finished product shall then be tested for proof under the first part of this specification.

SHELLAC MARKETS

The shellac market is highly speculative, due to the wide variety of factors which have been seen to enter into the production. During recent months a great scarcity has caused the price to rise above a dollar a pound. Before spring, however, the importers predict, the best grades may be obtained at fifty cents per pound.

A free market condition is said to be desired by all, and for this reason the shipping season commences in early November and ends in May. With June the rainy season and the combination of moisture and intense heat endanger this free condition. From June to September, therefore, only lower grades are exported. The bulk of the shellac comes from Calcutta via Indian Ocean, Red Sea, Suez Canal, Mediterranean Sea to European and U. S. Atlantic ports. A portion goes to China and Japan to be shipped to American Pacific ports.

INDUSTRIAL USES

This substance has a very wide application in both the dry and varnish forms. As a molded product it is used in buttons, phonograph records, emery wheels, toilet articles, insulations, mica products, oilcloths, linoleums, sealing wax, hats, fireworks, paper, etc. As a varnish its applications are too numerous and well known to require mention.

Each particular requirement must be met by a thorough analysis of the conditions surrounding its use. Where purely ornamental purposes are to be served it is economical to employ the cheaper grades. Here color is usually the determining quality. When the chemical purity and mechanical strength are involved and the color is not material, the garnetlac grades are found to serve best.

We especially appreciate the assistance of Mr. D. W. Mulford in the preparation of this article.

BIBLIOGRAPHY

Indian Forest Memoirs. "A Note on the Tachardia Lacca." By E. B. Stebbing.
Agricultural Journal of India.
Franklin Inst. Journal. H. E. Endemann, vol. 164, p. 285.
Shellac Facts. Cuts on Native Methods. Rogers-Pyatt Shellac Co., New York.
Miscellaneous Data. H. W. Peabody & Co., New York.
Angelo Bros., Calcutta, India.

Mineral Leasing Bill

The general mineral leasing bill again is in conference, with bright prospects for an early agreement. This measure, which has a direct effect on 700,000,000 acres of public land and directly involves 6,500,000 acres of possible oil land, 70,000,000 acres of coal lands, 2,700,000 acres of phosphate land and 3,500,000 acres of oil shale land, has been under consideration in Congress for seven years. This is the fourth time the leasing bill has been passed by the House.

The House refused to allow the embodiment into this bill of the section of the Senate bill which would modify the decree of dissolution against the Standard Oil Co. of New Jersey. It also refused to embody in this bill the section of the Senate bill which provides that corporations engaged in producing or refining petroleum shall maintain the same price for their products where the stockholders of any one of such corporations own or control 25 per cent or more of the stock of any other of such corporations.

The House committee recommended that the fund accruing from leases should be divided as follows: 45 per cent to the Reclamation Fund, 45 per cent for the State and 10 per cent for the Federal Government. This was changed on the floor of the House, however, so that 70 per cent of the fund from past production would go to the Reclamation Fund, 20 per cent to the State, and 10 per cent to the Government. For future production 60 per cent is to go to the Reclamation Fund, 30 per cent to the State, and 10 per cent to the Government.

A provision in the House bill reserves helium production for the Government. While objection was made to this provision as being over-protection, it was allowed to stand mainly on the advice of the War Department that helium could be extracted from natural gas without interfering with oil or gas operations.

Development of American Research*

BY VLADIMIR KARAPETOFF

FAR be it from me to urge greater emphasis upon research in our universities simply for reasons of national safety or because of advantages in competitive foreign trade. I shall not even urge it because of its evident importance in medicine, agriculture, engineering or government. No, I believe that our enlightened public opinion should rise to a point where it will demand recognition and support of investigators in pure mathematics, in theoretical physics and chemistry, in the study of nature and man, in philosophy, languages and literature, in fact, in any branch of human activity, no matter how remote a subject of investigation may be from our bread-and-butter problems. If we are to profit permanently by research—I am almost tempted to say if we are to become like older civilized nations in this respect—we must give up "practical" and mercenary ideas on research, and promote research for its own sake. It is like unto the Biblical precept that we must give up the ordinary sense of life in order to find the higher sense of life.

PURE RESEARCH SHOULD THRIVE IN UNIVERSITIES

There are many good reasons for which pure research should thrive in universities; in fact, great universities in Europe are considered natural centers of higher learning and investigation. This function of the universities is not always clearly understood in this country even by persons upon whom their administration and support are dependent. A teacher in elementary subjects need not necessarily be an original investigator or deep scholar. If he is a "big brother" to his students, he can introduce them successfully into the intricacies of elementary chemistry or French 1 and leave a beneficial lasting impression upon their forming characters. But a professor of an advanced subject must be at least a fairly deep scholar if not an original investigator of first magnitude. Only then can he enthuse his students and open before them wider vistas, that inspire both for knowledge and for action. It used to be an education in itself to sit at the feet of Lord Kelvin or Von Helmholtz.

MEN OF HIGH CALIBER LOST TO THE WORLD

The situation is this: Men of such high caliber sometimes do not find their real power until later in their lives. In the meanwhile the lure of the industrial world, of consulting practice, or text-book writing, too much elementary teaching, lack of literary work, lack of laboratory or library facilities, scarcity of research assistants, no appreciation, no place to publish the results of their research, financial worry, and lack of opportunities to travel and to meet fellow workers in other institutions or at conventions—all these factors dull their brilliant powers and bring an irreparable loss to the whole world. These men have no unions, no spokesmen, no influential organs of their own; they valiantly fight their battles each for himself, and they die at their posts meek, faithful and unheard of.

We hear too much about lack of university buildings, and an impression is sometimes unconsciously conveyed that the principal problem is to get more buildings. But I say that much brilliant pioneer work by men like Bunsen or Faraday has been done with most meager possible facilities. A good laboratory tends to encourage purely experimental research at the expense of analytical thinking and deeper interpretation. Curves, tables, experimental data of all kinds, are being published in an alarming quantity by mediocre men who have easy access to laboratory facilities. What we need in this country is more scientific men of prophetic vision, interpreters of the world, men of superior analytic and synthetic power who need no marble halls for their creative output; but such men grow only on a fertile soil, with a background of research and appreciation of culture behind them. These superior men step out of the background of a large number of less-gifted investigators and they lean upon those left behind for data, for companionship and for appreciation and approval.

As far as the higher form of university life is concerned, that is, research, what we need the most in this country is the correct attitude. Money, facilities and results will come in due time. This correct attitude may be summarized as follows:

CORRECT ATTITUDE SUMMARIZED

1. Consider all scientific research, no matter how theoretical and remote from practical ends, to be a necessary and important factor in the life of a civilized country and the mainspring of its healthy progress.

2. Research has to be multiplied a hundredfold in all its forms, as is the case in Germany, so that every young American investigator could easily find his place and problem, and would not feel like the sole survivor of a sunken bark.

3. Do not expect immediate tangible results from a newly established research center any more than you expect them from a recently planted orchard. Take good care of it and it will bear abundant fruit in due time and for many years to come.

4. Provide living salaries for younger teachers in universities, in order to be reasonably sure of securing a large number of promising young men, who later may develop into research stars of different magnitude.

5. Do not lay undue emphasis upon experimental facilities and investigations. This country is markedly deficient in high-grade analytical thinkers, capable of sublime generalizations in science. No effort should be spared in seeking out and developing such men, and placing them under working conditions under which they can give to the world their best.

Registration of Engineers in Iowa

It should be generally known that a law was passed by the last General Assembly of the State of Iowa requiring registration of all professional engineers and land surveyors and providing in Section 10 for their registration by Jan. 4, 1920, upon their professional qualification without examination. From Jan. 4 to July 4, 1920, registrations will require a technical examination before the Board. After July 4, 1920, practice in the State of Iowa without a registration certificate will be a punishable offense. The penalty imposed for such offense will be a fine of not less than $100 or more than $500. Application for registration, copy of law and instructions, from K. C. Kastberg, secretary Iowa State Board of Engineering Examiners, Box 923, Des Moines, Iowa. Other members of the Board are Seth Dean, L. M. Martin, F. W. Stubbs, and Alvin Le Van.

---

*Part of an address to the Cornell Alumni Association of Cleveland on "Significance of Research in American Universities."

Potash Recovery From Blast-Furnace Gases in England

A Description of Potash Recovery as Carried Out in Connection With English Blast-Furnace Operations, Together With Notes on the Activities of the Potash Production Bureau in Cement Dust and Other Fields

BY HAROLD HIBBERT

SOON after the outbreak of the European war in 1914, the British Government found itself in a precarious position in so far as the available supplies of potash were concerned, since up to that time the greater part of these had been obtained from Germany. As is well known, this product is used in connection with fertilizers and explosives, and also forms one of the basic raw materials for the manufacture of glassware. As the war progressed, the home manufacture of special optical glass for various scientific instruments, such as field glasses, microscopes, lenses, prisms, etc., became a matter of prime importance, hence a domestic supply of potash became imperative. Prior to 1913, the pre-war requirements of potash (potassium chloride) in the various countries were estimated[1] to be roughly as follows:

	Tons
United Kingdom of Great Britain and Ireland	35,000
United States and Canada	300,000
France	50,000
Italy	50,000
Germany	600,000

Thus it became necessary to devise some means of finding new sources of this material. The British Government created a special government department known as the Potash Production Bureau, which was attached to the Ministry of Munitions, the function of which was to stimulate potash production.

Of the various schemes submitted to the Bureau, the one which appeared to offer the most promising prospects for quick development and production was that in connection with the recovery of potash from the dust carried over in blast-furnace gases. Experiments carried out prior to 1914 at the plant of the North Lincolnshire Iron Co. served to indicate that this dust contained considerable quantities of potash salts, and as a result of the data submitted a company was formed, known as the British Potash Co., Ltd., with a capital of £100,000, of which the British Government supplied £50,000, thus becoming the owner of one-half the stock. The remainder was subscribed for by the British Cyanide Co. either directly or indirectly through their friends, especially those connected with the North Lincolnshire Iron Co., at whose plant the first large-scale experiments were performed. Considerable experimentation and research work have since been carried out both in the laboratory of the British Cyanide Co. and in connection with the various blast-furnace installations. It was decided by the British Potash Co., Ltd., that the most rational policy to adopt would be to have one central collection depot to which the potash dust from the various blast-furnace plants could be shipped for the extraction of the potash content, and in furtherance of this idea, a plant was erected at Oldbury on land adjoining that owned by the British Cyanide Co., where all the recovered blast-furnace potash dust is now being "treated."

TECHNIQUE EMPLOYED IN THE RECOVERY OF POTASH DUST FROM BLAST-FURNACE GASES

The principal incentive to the earlier study of the removal of potash dust from the blast-furnace gases was not primarily the recovery of potash, but the great economic advantage to be obtained in the saving of fuel effected by using such "cleaned" gases in connection with pre-heaters, economizers, steam boilers, etc. Thus it has been shown in actual practice that using a cleaned gas—namely, one from which the dust has been removed—the stove surface area for pre-heating the air-blast can be reduced in the ratio of 3 : 5 as compared with gas from which the dust has not been removed. Furthermore, in the utilization of a "dust-free" gas in connection with economizers or gas engines a much-increased efficiency is obtained, resulting in the elimination of considerable boiler capacity, with the further advantage that it is no longer necessary to keep one or more boilers out of commission for cleaning purposes. It has been proved definitely that freeing the gases from dust undoubtedly results in a large saving of the coal employed for power purposes. When the question of finding the most efficient method for removing the dust came up for discussion, it is understood that the well-known Cottrell process of electrostatic dust precipitation was favorably considered, but that, owing to various reasons not fully understood, attention was focused on the Halberg-Beth bag system of dust collection. This is a German-patented process which was taken over by the British Potash Co., the method consisting in bringing about a primary deposition of the coarser dust particles in large iron chambers fitted with a simple "baffling" device which takes out coarse and medium-sized particles, after which the hot gases are filtered through long cotton bags arranged in iron chambers. These bags are provided with a mechanical shaking arrangement for throwing down the dust in order to prevent clogging. In this way the fine dust is collected separately from the medium and coarse. It is found that the heavy coarse dust contains 2 to 3 per cent soluble potash, the medium 3 to 10 per cent, and the fine dust which collects in the bag 10 to 50 per cent. The fine dust (and in those cases in which the potash content warrants it, also the medium sized dust) is then shipped to Oldbury for treatment.

In the bag-house system of dust collection it is obviously important that the temperature of the blast-furnace gases (which issue at about 500 deg. C.) should be reduced to 125-150 deg. C. in order to prevent the cotton bags from being destroyed. The maximum temperature thus must not exceed 150 deg. C., while on the other hand care must be taken that it does not fall below 125 deg. C., since otherwise moisture will be deposited, and clogging will take place. It is evident that considerable care is necessary to prevent any sudden rush of hot gas, since such might bring about the destruction of the entire bagging equipment. Apparently no steps have been taken to decrease the inflammability of the bag material, although a suggestion has been made to impregnate with either ammonium tungstate or silicate of soda solution. It is claimed that the "bag" should last for about twelve months' continuous operation before renewal is necessary.

---

[1] *Chemical Age*, July 19, 1919. This does not take into account the salts, such as the sulphate, etc.

Treatment of the Potash Dust

The treatment of the potash dust consists in a simple lixiviation of the material with water (mother liquor from a previous run is employed), the resulting sludge being separated by the use of an Oliver filter. The solution is evaporated, allowed to crystallize, and centrifuged, the product thus obtained containing 80 per cent soluble potash in the form of chloride. No chemical treatment is necessary at any stage of the purification process.

The following typical analysis shows the content of an average sample of the finished product:

	Per Cent.		Per Cent.
KCl	72.16	H_2O	12.36
K_2SO_4	6.65	Insol.	0.25
NaCl	8.56	KCN	0.10
			100.08

It is of interest that the iron ores occurring on the east coast of England contain sufficient chlorides in the original iron ore to insure all the potash volatilizing in the form of chloride, while those on the west coast contain a little sulphur, so that a small amount of sulphate is obtained.

Method of Increasing the Potash Recovery

Experiments carried out by the British Potash Co., Ltd., have shown that the addition of a small amount of common salt to the blast-furnace charge in certain cases increases the yield of potash obtained (British Patent 112,338) which is especially true of ores relatively free from chlorides, and from which in consequence a considerable quantity of the potash would otherwise find its way into the slag. This applies to those ores occurring on the west coast of England, and also to certain Welsh ores.

In one or two instances it has been found that the recovered potash salts may contain a small amount of cyanide, in which case it is necessary to remove the latter by a special process of recrystallization.

List of Potash Recovery Plants in Operation

There are at present three blast-furnace plants collecting dust in bags for the recovery of potash, namely, North Lincolnshire Iron Co., Palmers Shipbuilding & Iron Co., and Ebbw Vale Iron Co. In each of these plants common salt is added to the blast-furnace charge to increase the potash yield. In addition to these, four other blast-furnace plants, viz., Blaenavon Iron Co., South Wales; Barrow Hematite Co.; Baldwin's, Ltd., South Wales, and Millom & Askam, Cumberland, are being equipped with similar installations, while the Ebbw Vale plant has commenced the erection of a second unit.

Cost of Erection and Operating

It is claimed that it is not economical to build an operating unit of bags capable of handling more than 1,000,000 cu.ft. of gas per hr., the present cost of such an installation being £40,000 (approximately $200,000).

No definite statement could be obtained as to the actual cost of operating, but it would seem that the labor cost and the necessary operating power are both higher than in the case of a Cottrell installation.

Recovery of Potash by the Lodge Fume Co. Process

The Lodge Fume Co. has been formed to develop certain patents (for dust recovery from gases) granted to Sir Oliver Lodge, on lines closely related to those of Cottrell, and following the successful small-scale experiments a large plant is now in process of erection at the Skinningrove Ironworks, Yorkshire, which was expected to be in operation in August. It has been designed to treat the entire output of 4,000,000 cu.ft. of gas from the usual closed-top blast-furnace working on local ores, no salt addition being necessary in this case.

The equipment has apparently been planned on somewhat similar lines to the well-known Cottrell installations, namely, a series of vertical iron plates with rods placed centrally. It is intended to operate at 70,000 volts, 7 to 10 hp. being required to run the system. The annual output of potash is expected to amount to not less than 1000 tons of 80 per cent material, and the iron company proposes to erect its own refining plant. It is anticipated that not more than two men and two boys will be required to operate the entire plant.

Cost of Installation

This plant, which is designed to treat 4,000,000 cu.ft. of blast-furnace gas per hour, is estimated to cost £35,000, as compared with £40,000 for a single unit of the bag system capable of handling only 1,000,000 cubic feet.

Recovery of Potash by the Cottrell Process

An experimental Cottrell plant was installed in 1918 by Huntington, Heberlein & Co., Ltd., the British representatives of the International Precipitation Co., at the works of the Workington Iron & Steel Co., Ltd.

Certain alterations in the design were soon found necessary, and these were subsequently carried out, though there was considerable delay owing to difficulties connected with the supply of labor and materials. The reconstructed plant comprises thirty-six 12-in. pipes 15 ft. long, and arrangements have been made so that the blast-furnace gas can be tapped from the main without interfering with the operation of the boiler plant.

The experiments at Workington were the first to be carried out in England on a comparatively large scale, and as is usual under such circumstances, many experimental difficulties inherent to this particular proposition had to be overcome. With the knowledge so obtained, it is now claimed that it will be possible to erect plants of any size required which will operate with an efficiency of 90 per cent or better.

Comparison of the Bag and Electric Systems of Potash Recovery

The outcome of the Skinningrove and Workington experiments is awaited with considerable interest in order that a direct comparison of operating costs may be made between the electrical method of potash recovery and the Halberg-Beth bag system of dust collection. From the above facts it would seem that the cost of equipment and installation of the latter process is roughly four times that of the former, and the operating charges are also apparently higher, due to the increased labor charges and the higher depreciation. Also, the horsepower necessary to force the hot gases through the filter system is much greater than that required to operate the electrical installation.

In view of the pronounced success of the companies operating the Cottrell system of recovery in connection with cement plants in America, there would seem to be little or no doubt that an equal measure of success would be achieved in connection with the recovery of potash from blast-furnace gases.

No definite information could be obtained as to the present cost of production of 80 per cent muriate of potash, but in view of the increased output in this field and the number of new installations, together with the fact that one plant is already installing additional equipment, the claim of the British Potash Co. that it expects to be able to produce this material at prices low enough to compete with German potash would seem to provide a sufficient stimulus for the large iron and steel companies in America to undertake similar experimental developments.

It is evident from the analysis of typical English ores, quoted below, that the American ores in many cases contain even larger quantities of potash, so that American iron and steel producers should be in a position to achieve equally valuable commercial results.

POTASH CONTENT OF TYPICAL ENGLISH IRON ORES

The ores on the west coast contain roughly from 0.2 to 1.30 per cent of potash calculated as chloride of potash, an average sample of the flue dust analyzing approximately as follows:

	Per Cent		Per Cent
Insoluble matter	82.10	Sodium chloride	1.9
Potassium chloride	7.82	Water	8.0

Those on the east coast contain a potash content varying roughly from 0.2 per cent to around 1.5 per cent calculated as chloride of potash, equivalent to 1.3 to 0.95 per cent K_2O. A typical "flue dust" analysis showed:

	Per Cent		Per Cent
Soluble potash (Calculated as KCl)	55.3	Calcium carbonate	10.4
Sodium chloride	4.0	Silica	8.9
Ferric oxide (Fe_2O_4)	11.7	Magnesia	1.0
Zinc sulphide	2.2	Carbonaceous matter, etc.	6.5
			100.0

The potash (K_2O) content of English iron ores may thus be said to vary between 0.126 and 0.98 per cent as compared with American iron ores, which average from 0.29 to 2.07 per cent, according to a large number of analyses run by Mr. N. C. Gellert of the Gellert Engineering Co., Philadelphia, Pa.

RECOVERY OF POTASH IN CEMENT PLANTS

While in England special emphasis has been laid on the extraction of potash from blast-furnace gases, considerable experimental work has also been done on the recovery of potash from the dust in the gases from cement kilns. The somewhat slower industrial development is probably due to the greater activity and interest shown by the blast-furnace operators and the evident fuel economies which can be effected by the use of a dust-free gas. On the other hand, little or no use is at present made of the latent heat in the waste gases from cement kilns, so that this consideration did not, of itself, make the same striking appeal to the English cement manufacturers. An experimental installation is already in operation in connection with the gases from a cement plant operating the wet mix method, in which the bag system of dust recovery is employed, and arrangements have been completed for the installation of a recovery plant in connection with a new modern cement plant of 1600-bbl. capacity, also operating the wet mix process. The type of recovery apparatus to be employed will be definitely decided upon after the relative cost of potash production by the bag system, as compared with the electrical process, has been definitely established. There is reason to believe that rapid progress will be made in this field during the next few years.

PREDICTION OF BRITISH INDEPENDENCE IN THE POTASH FIELD

The Potash Production Bureau of the British Board of Trade is convinced that by the utilization of both sources of production the country will be made entirely independent of outside sources of potash.

While undoubtedly much greater progress has been made in America with respect to economies to be effected in the cement industry by the utilization of the latent heat in the waste gases as well as in the recovery of potash from the dust, there would seem no reason to doubt that much of the gas from blast-furnaces can be similarly treated with correspondingly favorable results from the fuel standpoint as well as from that of potash recovery. The way, in fact, has already been pointed out in the admirable papers by Messrs. Wysor,[1] Gellert,[2] and Bradley,[3] and it now only remains for the iron and steel manufacturers to take advantage of the pioneer work already carried out by Cottrell, Linn Bradley, Wysor, Gellert and others (of whom the scientific and technical work of Linn Bradley, Research Corporation, New York, calls for special mention) to make America economically independent of outside sources of potash production.

STIMULATION TO INTEREST HERE

The fact that the average American iron ore contains on an average as much as or even more than the average English iron ore should serve considerably to stimulate interest in this matter. Of special interest too are the large deposits of brown hematite ores in Alabama, which are remarkable for their high potash content. By the use of these ores (with possibly salt addition) in ordinary blast-furnace practice and employing the Cottrell process for the recovery of the potash in the dust, it does not seem any exaggeration to assume that the necessary supplies of potash for the entire fertilizer requirements of the South could be provided from this source. Furthermore, the experimental work already carried out by Gellert with manganese ores shows that they contain a much higher potash content than iron ores, and his suggestion that a start should at once be made with such material would seem to represent a sound well-balanced judgment. We understand, in fact, that such a scheme, under his supervision, and with the active co-operation of the Research Corporation, New York, is already under way in one locality.

CONCLUSION

According to information supplied by the Bureau of Potash Production, England, large-scale experiments on the recovery of potash from blast-furnace gases have shown that:

1. By the removal of the dust from blast-furnace gases, the pre-heating surface for the air blast can be reduced in the ratio of 3 : 5.

---

[1] Bull. Amer. Institute Mining Engineers, 1917 (Jan. 17), with subsequent discussions.

[2] CHEM. & MET. ENG., vol. 20, p. 308.

[3] Bull. Amer. Institute Mining Engineers, 1917, pp. 209-228; CHEM. & MET. ENG., vol. 19, p. 457.

2. A considerable saving in coal consumption and boiler capacity can be effected.

3. The commercial results already obtained in connection with potash recovery indicate that blast-furnace gases are capable of providing a profitable source of potash production under normal competitive conditions.

THE INTERNATIONAL POTASH SITUATION

According to the figures supplied to the writer by the British Bureau of Potash Production, the total exports of potash and potash salts from Germany in 1913 were as given in Table I.

TABLE I.

Total exports of potash and potash salts from Germany in 1913 so far as separate figures are available:

	Metric Tons
Potash and wool grease ash	16,271
Caustic potash	44,112
Chlorate of potash	1,114
Sulphate of potash	133,358
Phosphate of potash	12
Nitrate of potash (saltpeter)	16,058
Manganate and permanganate of potash	1,521
Muriate of potash	393,320
Sulphate of potash and magnesia	59,207
Potash salts for manurial and other purposes:	
Carnallite containing from 9 to 12 per cent K_2O	520
Crude salts containing from 12 to 15 per cent K_2O	1,124,816
Salts containing from 15 to 20 per cent K_2O	49,687
Manures containing up to 38 per cent K_2O	460,865
Waste salts (so-called Stassfurt salts) unenumerated	40,269

Exports from Germany in 1913 of certain groups of chemicals in which potash salts are included with other salts:

	Metric Tons
Bromide of potassium, sodium, ammonium and iron; bromoform	405
Iodide of potassium, sodium and ammonium; iodoform	160
Ammonia, potash and soda alum and other similar products	24,733
Chromate and bichromate of potassium, oxide and hydroxide of chromium	2,627
Water-glass (silicate of potassium and sodium)	15,543
Ferro- and ferricyanide of sodium and potassium	2,294
Cyanide of sodium and potassium	6,678
Sulphide of potassium and sodium	9,226

The value of potash compounds imported into Great Britain from Germany in 1913 is shown in Table II.

TABLE II.

Detailed statement of values of potassium compounds imported into Great Britain from Germany in 1913:

	Value
Bichromate	£974
Bromide	7,827
Carbonate	33,555
Caustic	79,090
Chlorate	2,101
Cyanide	9,763
Iodide	10,351
Lyes	8,762
Meta bisulphite	1,146
Muriate	99,951
Oxalate	1,743
Permanganate	7,451
Phenylglycine	38,832
"Potash pot lye"	2,235
Prussiate	14,781
Potash salts (unspecified)	2,495
Sulphate	85,175
Sulphate muriate	22,935
Cream of tartar	149,562
Saltpeter	156,682
Salts other than the above to values not exceeding £1,000	12,269
Waste salt	50,193
Kainit	117,994
	£915,867

The pre-war imports from other countries are shown in Table III.

TABLE III.

Pre-war imports of potash and potash compounds into the United Kingdom, 1913.

Saltpeter:	Cwt.	Value
Total imports	237,880	£240,966
of which from		
Germany	149,975	156,682
Belgium	25,469	25,023
Br. India	60,006	56,631
Other potash compounds:		
Total imports	......	£630,234
of which from		
Russia		58,499
Germany	Entered Only by Value	441,436
Belgium		20,489
France		57,115
Sweden		12,634
Japan		30,654

The British Government has already announced its intention to allow the importation during 1919 of about 20,000 tons of Alsatian potash averaging 14 to 20 per cent K_2O. Also a further 50,000 tons of German potash (80 per cent K_2O), which is to be taken in part payment for goods supplied; and it would seem to be the policy of the government not to issue further permits except in so far as domestic supply is insufficient to cover the demand.

According to an interesting article on this subject in the *Chemical Age* (vol. 1, No. 5, 1919), it is claimed that the post-war requirements for potash will be much greater than the pre-war requirements, and that while the former cost of production of 80 per cent potash is assumed to have been approximately £7 per ton, it cannot be expected that a lower price than about £15 to £25 per ton will be the rule for a considerable period of time.

This surmise is based on the assumption that for many years to come the world's requirements of potash will be far greater than can be met by the combined output from the Alsatian and German fields.

Attention is also drawn to the reported occurrence of rich potash deposits in the Italian colony of Erythrea, Abyssinia,[4] some hundreds of tons of this material with a chloride of potash content of 75 to 95 per cent having been exported during the war period. The extent and uniformity of these deposits, as well as of similar ones in Spain and Sicily, are still matters for investigation.

Of possible interest is the reference in the same article to the extraction of potash from leucite by a new Italian process. Leucite is a double silicate of potash and alumina containing, when pure, about 28 per cent K_2O, but the Italian product generally contains only 8 to 10 per cent. According to the new method the gangue can be separated electromagnetically, thus increasing the K_2O content to 15 per cent.

The writer wishes to express to the officials of the Department of Potash Production, Board of Trade, England, his appreciation of their kindness in favoring him with the major portion of the data outlined above. It would appear that no small amount of the success obtained is due to the energy and enthusiasm shown by them.

360 Garden Avenue.
Mount Vernon N. Y.

Belgian Wage Scale

The past and present labor situation in Belgium, which might serve for comparison with that in the United States, is given in the following news item taken from the *Fortnightly Information Review*, Nov. 1, 1919:

"In general, the present wage scale in Belgium, as compared with June, 1914, shows an increase from 150 to 200 per cent, according to Trade Commissioner Harry T. Collins, Brussels. Blacksmiths, machinists, etc., employed by the community receive 19 to 24c. an hour, which is an increase over 1914 wages of 225 to 285 per cent for an 8-hr. day. Carpenters receive 23c. an hour for a 54-hr. week, which is an increase of 153 per cent over wages in 1914. Mechanics employed in textile factories receive 18 to 22c. an hour, an increase of 261 to 294 per cent over their wages in 1914, with an 8-hr. day."

---

[4] *J. Soc. Chem. Ind.*, 1918, 291T.

Treating Antimony Ores*

BY GEORGE P. HULST†

PRIOR to 1914 there was little demand for antimony in this country; its use was limited almost entirely to the manufacture of type and bearing metals. Practically no antimony ore was mined here, the market being supplied principally from China, and the alloy was produced by a direct mixing of lead and antimony. The great world war, with its demand for shrapnel in hitherto undreamed of quantities, precipitated a great boom in the price of antimony. Nominally quoted at 6c. to 7c. in 1914, the price increased by leaps and bounds to 45c. in March, 1916. Under the stimulus of high prices many small mines were opened, for it became profitable to work ores containing as low as 20 per cent antimony. High-grade sulphide ores (stibnite), containing 55 to 60 per cent antimony, were received from Bolivia, China and Alaska. Low-grade sulphide ores, running from 20 to 45 per cent, were produced in Nevada, California, Idaho, Utah and Mexico; much of this ore was fairly rich in silver. The principal oxide ores came from Mexico and Oregon. The following analyses are representative of various types of antimony ore:

	Sb	Pb	Cu	Ag	Au	SiO_2	Fe	S	CaO	Zn	As
Oxide ore...	25.09	.....	....	....	....	46.02	0.95	0.40	10.98	0.30	0.22
Sulphide ore	55.20	.....	....	....	....	15.12	1.05	19.87	.....	0.40	0.25
Sulphide ore	37.16	11.30	0.10	34.0	....	7.60	0.50	17.05	7.40	0.36	0.10
Sulphide ore	41.55	18.00	0.20	76.0	0.04	5.60	0.25	18.17	0.85	0.25	0.10

The International Lead Refining Co. fortunately was equipped to handle these ores through residue and blast-furnaces. The charge consisted of a variety of sulphide ores containing Sb 20 to 60 per cent and SiO_2 6 to 45 per cent, oxide ores containing Sb 20 to 40 per cent and SiO_2 10 to 45 per cent. Secondary materials, such as battery plates, battery mud, lead oxide, paint, etc., together with refinery skins, softener skins and other refinery by-products, were treated along with the antimony ore to furnish the lead required. All silver-bearing antimony ores were treated in the residue furnace, the sulphur, iron and copper forming matte that carried part of the silver, the balance going into lead bullion. The antimony slag produced was sufficiently low in silver to warrant being smelted in the blast-furnace to antimonial lead.

The blast-furnace equipment consisted of two 5-tuyere, 42-in. round furnaces connected by flue to the bag house. On account of high zinc and arsenic in lead refinery by-products, we ran a slag of the composition SiO_2 26 per cent, FeO 40 per cent, CaO and ZnO combined 20 to 24 per cent. Net profit rather than metallurgy prompted a slag as low as possible in antimony, even though the lead content was increased. Average analysis of slag for 6 mo. showed Sb 0.66 per cent and Pb 2.36 per cent. Actual blast-furnace loss was 2.4 per cent antimony and 1.503 per cent lead. Due to sulphur and arsenic on the charge, some speiss was produced. The furnace charge varied from 2500 to 3000 lb. Coke ratio was 13 per cent. Blast pressure was maintained at 10 to 12 oz. The two furnaces smelted 60 to 90 tons of lead and antimonial material per day, producing 30 to 35 tons of antimonial lead of the following average analysis: Sb 13.00 per cent, Cu 0.15 per cent, As 0.75 per cent, Pb 86.1 per cent.

---

*Read at the Chicago meeting of the American Institute of Mining and Metallurgical Engineers, Sept. 24, 1919.

†Assistant general manager, International Lead Refining Co.

Need of Extensive Research in the Petroleum Industry

BY VAN H. MANNING

THE welfare of any industry must be considered in connection with the welfare of the people. Capital and labor cannot disregard the public; that must be represented and considered. A review of the American petroleum industry shows that the industrial development and general prosperity of the United States depend upon an adequate supply of petroleum. It was one of the prime factors in assuring victory for the armies of the Allies, and today our automobiles, trucks, farm tractors and motor boats are dependent on it for power, and few manufacturing industries can exist without it. There are no known commercial substitutes for gasoline or lubricating oils, and, in fact, petroleum in one form or another reaches every household in the civilized world. As to the future, it is certain that the demand for petroleum will increase.

Faced with this growing need for petroleum, we have to consider seriously the means whereby an adequate supply for the future can be obtained. We know that the domestic output does not meet the present consumption, and that the amount of this deficit will probably continue to increase. Of the original available supply underground, it is estimated by the U. S. Geological Survey that we have consumed 40 per cent that is unreplaceable. A diminishing output with increasing consumption will make the United States more dependent on foreign fields.

It is true that there are vast oil reserves in foreign countries, and if these fields could be developed without hindrance, they could, even though consumption continues to increase at the present rate, probably meet the world's demands for the next ten years at least. Prediction beyond the ten-year period is not safe, for too many uncertainties are involved.

In meeting the world's needs, however, the oil from the United States will continue to occupy a less and less dominant position, because within the next two to five years the oil fields of this country will reach their maximum production and from that time on we will face an ever increasing decline.

DOMESTIC OIL FIELDS UNABLE TO MEET PRESENT HOME DEMANDS

We thus see domestic oil fields unable to meet our home demands under present methods of utilization and manufacture. This startling fact cannot be ignored. We must and can obtain a more efficient utilization of petroleum by proper investigative work. Research work and scientific development work should be actively stimulated.

Our efforts should tend toward obtaining perfection in processes, mechanical equipment, and in the proper development of our plants and processes. The day of empirical formulas and rule-of-thumb methods should not be passively allowed to continue. It is only a scientific research and the adoption of methods pointed out by this research in which natural laws form a basis for the quality and value of any product that we can hope to obtain the most valuable products out of petroleum.

Today there are many laboratory processes which have not been developed further simply because of insufficient funds to install them commercially. One object of research would be to test out on a commercial scale many of the laboratory processes now dormant commercially because of insufficient funds. Another object of research should be to correlate the pertinent facts of all investigative work and start supplemental research at the point where it is needed. This procedure will avoid costly repetition. The result of all past and current work should be properly correlated and brought under one large head, so that the greatest good can be accomplished and duplication minimized.

RESEARCH AND EXCHANGE OF INFORMATION NEEDED

It is the research man who should point out the manufacturing losses, and indicate the necessary investigative work whereby these losses will possibly be reduced or eliminated. These results should not be stored in the records of one company, but should be available to other manufacturers, so that they may profit by the experience and findings of their neighbors. A proper exchange of information must save much costly duplication of work.

The petroleum industry, valued at billions of dollars annually, is essential to national efficiency, and national efficiency can be attained only through scientific research. The necessity of such research is becoming recognized more and more by the large industrial units, some of which spend thousands of dollars annually for scientific investigations. Many petroleum organizations have scientific bureaus, but much of the knowledge these bureaus gain is confined in the archives of the company's laboratory.

The need of research is recognized in many professions, and particularly in medicine. The medical profession is essential to personal health and life, and vast sums of money have been donated to medical research. As a result, typhoid fever, smallpox and many other deadly diseases have been mastered. The money donated to medical research has been refunded many times over through the saving of life and the increase of human efficiency, and intensive research in the petroleum industry would yield results incomparably more valuable than the cost of the work. A fraction of the sums spent in medical research would, if expended in petroleum investigations, bring about improved methods that would vastly increase efficiency in the utilization of each barrel of oil. In 1918 the value of the output of crude oil and refined products in the United States was about $2,500,000,000. Certainly the petroleum industry can afford to spend more than has heretofore been spent in research to discover new methods and perfecting those in use, for thereby the recovery of oil will be increased and utilization will be far more efficient. In this way the cost to the consumer will be lessened and a rapidly diminishing commodity, one essential to our existence, will be conserved.

SECRETARY LANE QUOTED

In conclusion, I do not believe that this problem could be emphasized any more strongly than has been done in a letter to me from Secretary Lane, of Sept. 24, from which I quote the following paragraphs which have a direct bearing on the above subject:

"It is not an exaggeration to say that millions of dollars must be spent in experiment before we know the many services to which a barrel of oil can be put. There is almost an indefinite opportunity for research work along this line. Petroleum is a challenge to the chemists of the world. And now the world is dependent upon it as it is upon nothing else excepting coal and iron, and the foodstuffs and textiles. It has jumped to this place of eminence within twenty years and the world is concerned in knowing how large a supply there is and how every drop of it can best be used.

"We are behind the rest of the world in the use of our oil for fuel purposes. We are spendthrifts in this as in other of our natural resources. We can get three times as much energy as we do out of our oil through the use of the Diesel engine, yet we are doing little to promote development of a satisfactory type of stationary Diesel, or marine design. Instead of seeing how many hundred millions of barrels of oil we can produce and use, our efforts should be to see how few millions of barrels will satisfy our needs."

REQUA SEES DAWN OF "REAL PETROLEUM ERA"

The views of Mr. M. L. Requa, in a letter to me of Sept. 25, have such an important bearing on this great topic that I think it well also to add a few pertinent statements from his letter on this subject.

"I am on record in various published addresses as to my attitude concerning the petroleum problem, and I think it unnecessary to repeat those statements. I cannot, however, refrain from pointing out briefly the acute need that I believe exists for constructive and co-operative work of the character that you are proposing. That it has never been done before has been due to two causes: one, the less pressing need, and the other the lack of realization upon the part of the industry of the necessity for co-operative and constructive action.

"Because of the tremendous increase in the consumption of petroleum products, we have confronting us problems that have been of little concern in the past, but will be of very much greater concern in the future. Satisfactory answers cannot be made, except through constructive action upon the part of the industry. There is no alternative, in my judgment.

"We are, in my judgment, just beginning to see the dawn of the 'real petroleum era.' All signs point to a demand for the product in the future that will far exceed anything in the past. I am optimistic enough to believe that the Diesel engine will be perfected, and become of universal application. If so, the day of the steam unit will have passed.

"The extraction from a barrel of oil of all of the component parts, so far as is commercially practicable, and the distribution of those products in channels of trade, in a useful and economical way, rather than their destruction as is now the case, is a matter of highest concern."

Government Assumes Responsibility for Failure of Castor Bean Crop

More than 18,000 Southern farmers are to be reimbursed for losses sustained in efforts to raise castor beans for the Government. The Board of Contract Adjustment of the War Department has ruled that the Government in furnishing seeds, of which a large percentage failed to germinate, had incurred liability and that the case comes within the purview of the informal contract act. The Government undertook the stimulation of castor bean growth early in the war when it appeared that a sufficient amount of castor oil would not be available for use as a lubricant for airplane engines. The seeds were secured in India and proved to be unsuited to climatic and soil conditions in the U. S.

Relationship Between Transverse Rail Fissures, Flakes and Defects in Fusion Welds

A Consideration of These Apparently Diverse Imperfections Indicates the Strong Probability That All Are Due to One Cause: Films of Oxide Between the Metallic Grains—Examination of Defective Rail and Gun Steel Under Strain Would Probably Throw Much Light on This Point

By S. W. MILLER*

THE subject of transverse fissures in steel rails is one which is of vital interest, not only to the railroads, but to everyone who travels on them. A very great amount of work and time has been spent trying to determine their exact nature, and especially their cause; and a large amount of information has been secured in regard to them by competent observers who have every opportunity for so doing.

At the meeting of the American Institute of Mining Engineers in February last, George F. Comstock presented a paper on this subject, and the Rail Committee of the American Railway Engineering Association has recently reported on the matter, an abstract of its findings appearing in the *Engineering News-Record* of March 27, 1919, p. 610. Mr. Comstock's paper and the report of the Rail Committee contain probably the latest information in regard to transverse fissures.

The difficulty experienced with flaky gun steel has been considerable, at least in America, and a great amount of investigation has been carried on in order to determine the cause and eliminate the trouble. Of course, its prominence has been aggravated by the greatly increased demand for gun forgings during the war. Two papers on the subject were presented at the February meeting of the American Institute of Mining Engineers, which attacked the trouble from different standpoints, and which were thoroughly discussed. In the issue of CHEMICAL & METALLURGICAL ENGINEERING for March 15, 1919, there is a very important article by Dr. Giolitti, the Italian metallurgist. These articles contain probably all of the important information in regard to flaky steel.

It may seem a far cry from the above two subjects to that of fusion welds, but, as the materials in which the two former defects occur are originally steel castings, and as a fusion weld is the same thing except on a smaller scale, it would seem reasonable that the defects in all three cases would be of the same general nature, although likely to be aggravated in the case of welds because of the lesser degree of skill and knowledge possessed by the average operator, and from the fact that but little attention has been given to defects in welds and to the methods of their prevention. The writer presented a paper at the February meeting of the American Institute of Mining Engineers in this connection. Since that time he has made further examination of heat-treated welds, and finds no reason to change his conclusions in the paper.

Furthermore, as bearing on the general subject, attention is called to a paper by J. C. W. Humfrey, on "The Intercrystalline Fracture of Iron and Steel," in the Carnegie Scholarship Memoirs, Iron and Steel Institute (1912), vol. 4, p. 80, and also to Mr. Humfrey's discussion of the paper by Prof. Zay Jeffries on "The Metallography of Tungsten" in the November *Bulletin* of the American Institute of Mining Engineers.

Short abstracts from all these references are given herewith in order to sustain the position which the writer has taken in regard to these defects, which briefly is that *they all result from the same cause, which he believes to be films of oxide, or other foreign matter, which lie along the grain boundaries and which impair the physical qualities of the metal.* These films may be so thin as to be ultra-microscopic, and yet may have a serious effect.

In Mr. Comstock's paper, the statement is made that there are two schools whose opposing beliefs are: first, that transverse fissures are the result of fatigue and independent of the quality of the metal; second, that the quality of the metal and the mill practice must have something to do with them. Mr. Comstock associates these fissures with high-phosphorus streaks, using 24 rails having them and 12 rails giving good service as a basis, and also concludes that reheating the rail blooms reduces the tendency toward forming transverse fissures. He does not take the position that the fatigue theory is disproved by his investigations, and attempts to reconcile the two opposing theories by showing that both are probably closely connected with the formation of fissures. He also states in closing that his "paper is presented with the idea of throwing a little light in a new direction on the internal conditions that help the beginning of transverse fissures in rails." In other words, Mr. Comstock tries to find the *starting point* of the transverse fissures found in service, and suggests strongly that segregation due to phosphorus is a probable contributing cause.

LATEST INFORMATION ON DEFECTIVE RAILS

The statements of the Rail Committee are well summarized in the *Engineering News-Record* of March 27, 1919, in "Progress in Study of Rail Quality":

> First—Mr. Waring's statement that deep etching as carried out by him on rails found with fissures either in service or during test brings out irregular markings associated with the fissures. He also states that a rail that performed well under test, though from the same heat as some of the defective rails, showed none of the markings. His conclusion is: "Since these rails were all from one heat, of a fairly uniform chemical composition, and rolled at the same time, and since they were all subjected to approximately the same amount of service in the track, it would appear as if these defects found in the rail heads are associated in some manner with the process of manufacture." And further: "An examination of all these deep etchings brings out the fact that these small internal transverse ruptures correspond in their location and appearance with

---

*Proprietor, Rochester Welding Works.

the nuclei of transverse fissures, and it is possible that they may be the original cause of such fissures."

Second—Mr. Young's closely allied statement is that his findings "are conclusive evidence that flaws and cracks exist in new rails which have been subjected to no strains except those developed in the rolling."

Third—Mr. Cushing's report as to the very much better quality of rails from some mills than others, based on the comparison of elastic limits and deflections, and that annealing removes the brittleness and increases the deflection. Dr. Dudley also makes the same statement with regard to annealing.

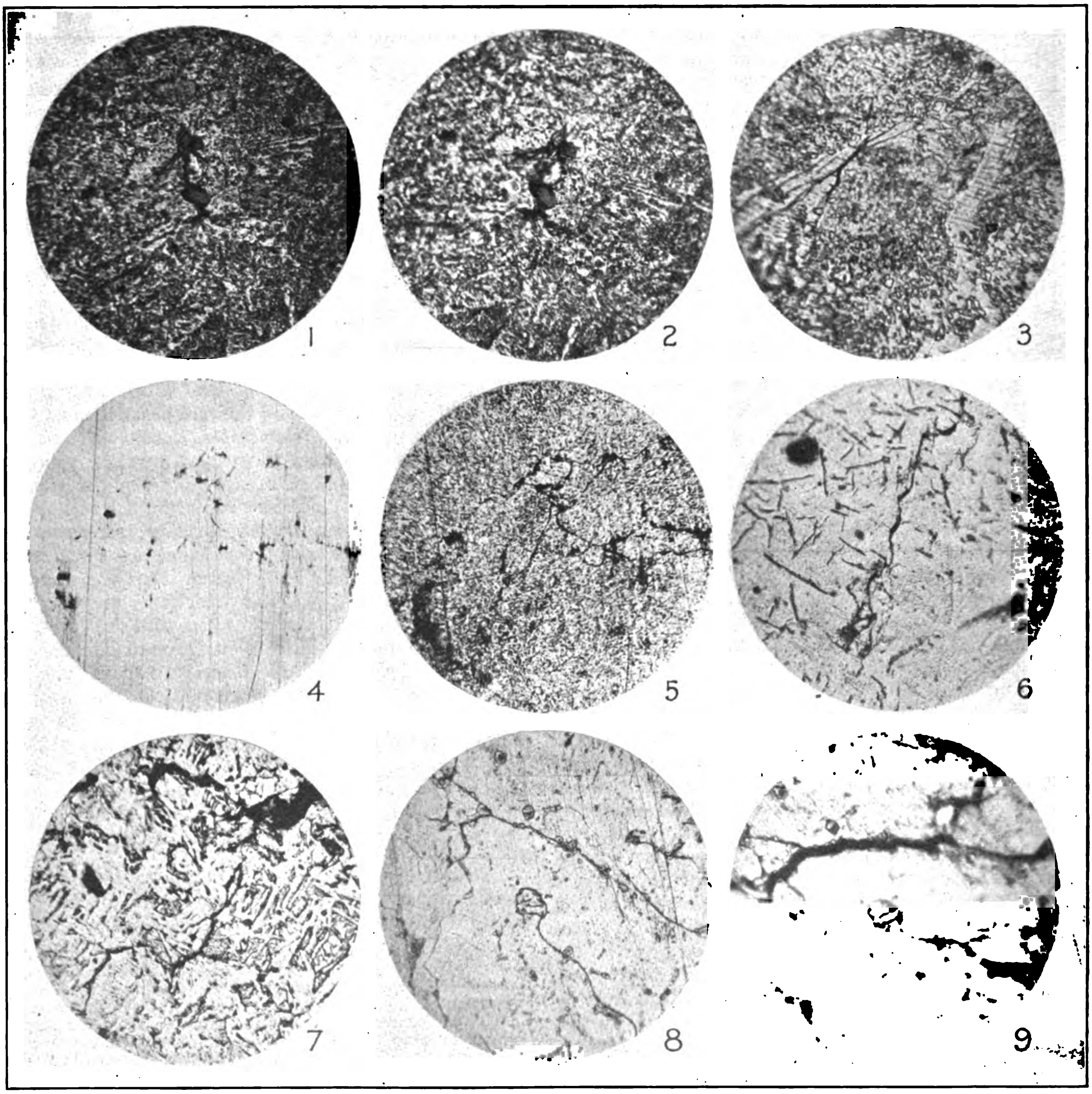
Fourth—The percentage of transverse fissures in direct rolled rails is ten times that found in rails from reheated blooms. In the latter there was one fissure per 5466 tons, and in the former one fissure per 531 tons.

Fifth—There is a strong belief that small cracks are produced in rail heads during the gagging.

With regard to flaky steel, the paper[1] by Mr. Clayton and his associates suggests seven possible causes, of which they seem to lean strongly toward No. 5, which is "overheating and non-uniformity of heat of ingot preparatory to forging."

The paper[2] by Mr. Rawdon concludes as follows:

"On the whole, the microscopic appearance of flaky steel leads to the following conclusions regarding the nature and origin of flakes. They originate in the ingot, in which state they have the appearance of inter-



FIGS. 1 TO 9

Fig. 1. Flaky gun steel. First evidence of distortion at two dots of manganese sulphide. × 430. Fig. 2. Same as Fig. 1 after further strain. No evidence of defects other than manganese sulphide before strain. × 430. Fig. 3. Rupture in ferrite grain boundary in flaky gun steel. No evidence of defects before strain. × 1200. Fig. 4. Defect in flaky gun steel beneath flake about ¼ in. from the flake. Unetched. × 200. Fig. 5. Same as Fig. 4 etched with nitric acid. × 200. Fig. 6. Intergranular rupture in electric weld as made. The needles are nitride of iron. × 430. Fig. 7. Intergranular ruptures in electric weld quenched from 1800 deg. × 430. Fig. 8. Oxide films in oxy-acetylene weld before straining. × 430. Fig. 9. Same as Fig. 8. but after strain. × 430.

---

[1] "Flaky and Woody Fractures in Nickel-Steel Gun Forgings," by Charles Y. Clayton, Met.E., Rolla, Mo., Francis B. Foley, Pittsburgh, Pa., and Francis B. Laney, Ph.D., Washington, D. C.

[2] "Microstructural Features of Flaky Steel," by Henry S. Rawdon, Washington, D. C.

crystalline shrinkage cracks. They occur in the cast metal along with the slag inclusions in the angles between the branches of the tree-like dendritic crystals. They persist throughout the history of the forging into the finished form as discontinuities in the metal, often associated with slag films, which have resulted from the working down of the slag inclusions with which they are associated from the beginning."

The present writer is strongly inclined to believe that the usual cause of flakes is as explained by Mr. Rawdon, but it would seem quite plausible that at times overheating of the ingot, as referred to in the paper by Mr. Clayton, would cause similar defects which would not be removed during subsequent forging. As evidence of this, the statement made by Mr. Humfrey in discussion of Prof. Jeffries' paper, and appearing in his original paper,[3] shows that intercrystalline brittleness can be produced by overheating, and this brittleness again removed by heating in a reducing atmosphere, such as that of hydrogen. Mr. Humfrey's statement referred to is as follows:

> We do, however, know of cases in which certain metals, which normally break through the crystals, may be so altered in character as to tend to break around them. Typical examples of this are:
>
> (*b*) Pure iron which has been annealed at certain temperatures and in certain atmospheres, and slowly cooled through a certain range. In this case there is evidence to indicate that the weakness is due to the formation of an iron-oxide eutectoid.

Mr. Humfrey was unable to find any microscopical evidence of oxide films around the grains even at high power, yet since the heating in a reducing atmosphere caused the rupture to pass through the grains, as in normal steel, he felt that these films must exist.

DR. GIOLITTI'S OPINIONS

Dr. Giolitti's entire article is worthy of the most careful perusal, especially the following statements:

> Flakes originate in tender alloy steels as intercrystalline cracks, probably intensified by inclusions and segregations. They can consequently be controlled by careful steel furnace practice, casting, soaking, reheating, forging and heat treating. . . .
>
> Of even greater importance, however, we feel that free iron oxide (scale and rust) be kept at the lowest possible point in the raw materials charged in the furnace. This refers to scale on the surface of the metal (rusty turnings and borings are never used) and free oxide in the puddled iron itself. . . .
>
> Starting from this pure iron, extreme care is used to prevent superficial oxidation during melting by maintaining a reducing flame in the open-hearth furnace at all times. . . .
>
> What I wish to emphasize is that chromium steel, properly made of pure materials in this manner under reducing conditions and containing no oxide, will never develop flakes. When so made you can pour it into an ingot of any cross-section and forge it as you like—either fast or slow, with reheating or without, with great or slight reduction (always providing the work is done within the correct temperature limits and with usual skill) and flakes will not appear. . . .
>
> On the other hand, a bath of metal properly made from correct raw materials will develop woody structure excessively if only a few kilograms of scale are thrown into the furnace even a long time before tapping. Microscopic examination of this defective metal seldom reveals an increased amount of inclusions, still we feel that this "oxidized metal" is flaky by virtue of its content of emulsified iron oxide, or some substance produced thereby which has diffused or broken up beyond the detection of a microscope.

There are many other statements in Dr. Giolitti's article that are equally positive, and which all point to the fact that oxide is responsible for flaky steel.

The examination of welds made by the writer, and which are summarized in his paper already referred to, was made by bending sections of welds about ⅜ in. wide and ⅛ in. thick, and examining them at different stages under the microscope. The same method applied to flaky steel showed two things: first, that the first evidence of rupture was at visible defects, such as dots of oxide or manganese sulphide; second, that where these defects did not exist, the first evidence of rupture was in the ferrite around the grain boundaries. As illustrating these points, photographs Nos. 1, 2 and 3 are shown. In none of the pieces from which these photographs were taken was any defect visible at 1200 magnifications that had the appearance of a crack or film of oxide.

RUPTURE IN WELDS DUE TO OXIDE FILMS

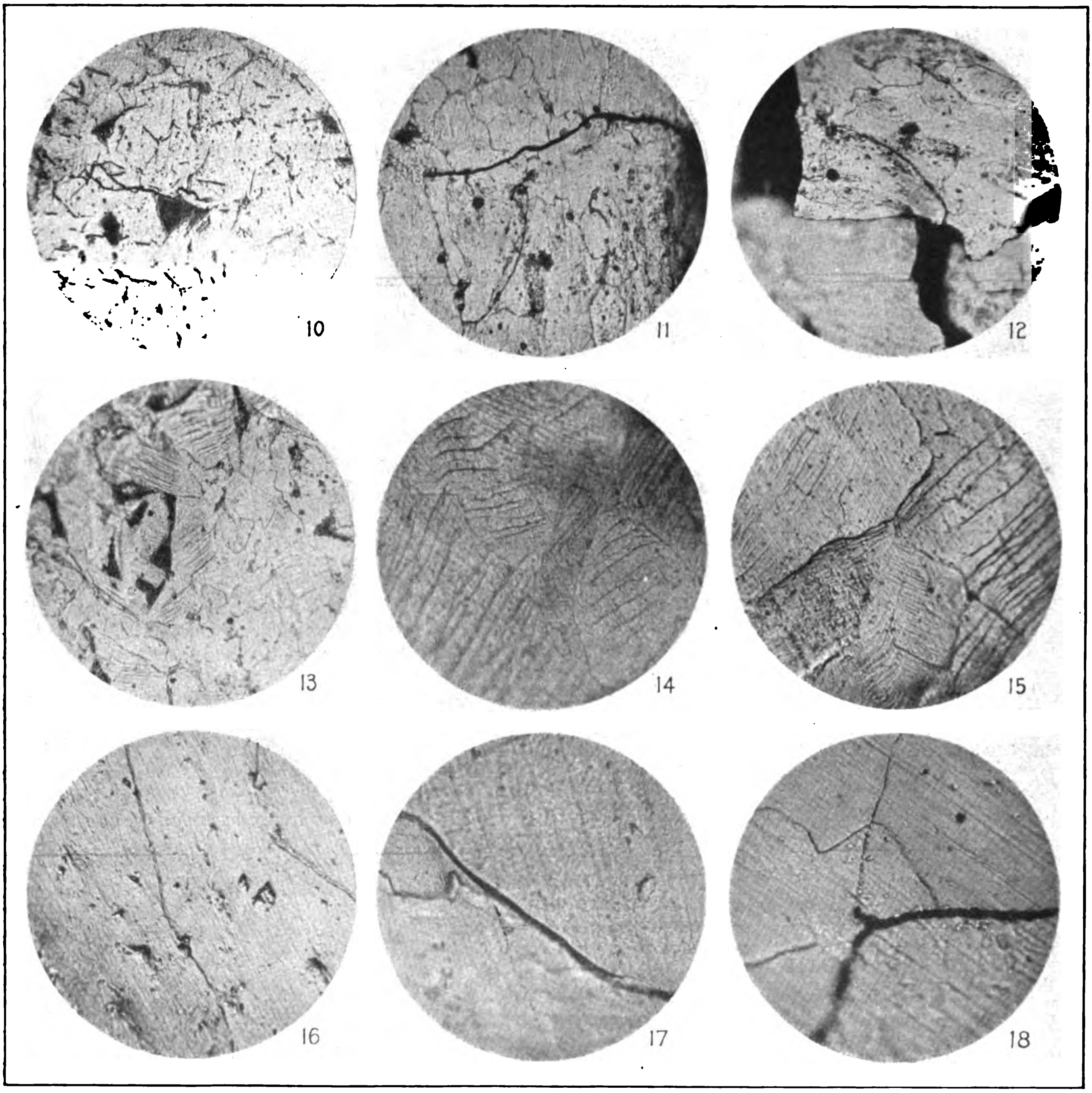
Coming now to the matter of welds, in his paper the writer concluded: first, that all metal-electrode arc welds rupture at the grain boundaries; second, that gas welds made with low carbon material, so that no pearlite exists in the weld, rupture through the grains by slipping as in normal steel; third, that where welds are made from welding rods having sufficient carbon, or other elements which preserve pearlite in the weld, the rupture is along the grain boundaries. Since this paper was presented, other conclusions have been reached, which apply to welds which received heat treatments. These conclusions are: first, that neither quenching from temperatures ranging between 1500 and 1800 deg. F. nor annealing within the same range will prevent the intergranular rupture of electric welds; second, that annealing pearlitic gas welds changes the path of rupture from intergranular to intragranular along the slip planes. The heat treatments referred to were done in an ordinary small electric furnace, no attempt being made to keep the atmosphere reducing. In many instances, a careful examination was made at 1200 magnifications of the polished and etched surfaces of the test pieces before bending in order to locate if possible any defects in the way of oxide films that might exist, but in all such cases, even where there were no visible defects, the paths of rupture were in accordance with the above conclusions. A few of the photographs showing these ruptures are reproduced in connection with this discussion.

It is well known that Armco iron is practically pure iron, the total impurities being less than 0.1 per cent. It has one peculiarity, as have all other materials of the same composition, which is its brittleness when heated to about 1700 deg. F. The writer made some attempts to determine the reason for this brittleness by heating pieces of it to different temperatures for different lengths of time, and finds the results shown in the photographs. Normal Armco iron when under strain develops slip bands, and the grain boundaries remain intact as in Fig. 14. When heated to 1700 deg. F. for ten minutes and quenched in ice water, the grain boundaries appear to be thickened, although it is difficult to judge this positively, the number of slip bands developed is much less than with normal material, and the giving at the grain boundaries is quite frequent. (See Fig. 15.) When heated to 1700 deg. F. and cooled slowly to 1600 deg. F. and quenched in ice water, there appear to be films around the grains as shown in Fig. 16. Under strain the ruptures were clearly intergranular, as shown in Fig. 17. Another test that was made was to heat a piece, ⅜-in. x 2-in., with an oxy-acetylene torch to about 1700 deg. F. and then to strike the piece while red hot on the end of an anvil. The heated section broke off short when struck, and the piece was caught in a tank of ice water. In a section prepared for the microscope, for a short distance back of the fracture the piece was seamed with grain boundary cracks in which in the unetched section material resembling oxide could be easily seen at high power. Etching the section showed that these defects were at the grain boundaries as in Fig. 18.

---

[3] J. C. W. Humfrey: "The Intercrystalline Fracture of Iron and Steel," Carnegie Scholarship Memoirs, Iron and Steel Inst. (1912), vol. 4, pp. 80-105.

These tests appear to show quite clearly that it is possible to produce in the normal iron a condition which is abnormal, and it appears that this condition is due to films around the grains. A similar condition is well known to exist in tool steel, and enough overheating does produce what is commonly called burnt steel. The cause of these films is not known, but the writer offers the theory that they are ultra-microscopic in many cases, and possibly of iron sulphide, due to the small



FIGS. 10 TO 18

Fig. 10. Intergranular rupture in normalized electric weld. The spots resembling pearlite are probably iron-iron nitride-eutectoid. The needles are iron itride. No defects visible in 6, 7, or 10. × 300. Fig. 11. Intergranular rupture in oxy-acetylene weld after slight strain. No evidence of films before straining. × 300. Fig. 12. Same as Fig. 11, but after heavy strain. × 300. Fig. 13. Same as Fig. 11 after normalizing. Distortion is by slipping in the grains. × 300. Fig. 14. Armco iron after straining. Distortion is by slip bands. × 300. Fig. 15, Armco iron heated to 1700 deg. and quenched in ice water. Distortion of grain boundaries increased. × 300. Fig. 16. Armco iron heated to 1700 deg. F., slowly cooled to 1600 deg. F., and quenched in ice water. Films appear around some of the grains. × 350. Fig. 17. Same specimen as Fig. 16 after straining. Few slip bands. Distinction heavy at grain boundaries. × 350. Fig. 18. Armco iron heated to 1700 deg. F., broken when brittle and quenched in ice water. Rupture intergranular. Oxide deposited around grain boundaries probably after rupture. × 350.

amount of manganese in the iron. The large rupture in Fig. 18 is probably due to the forcing open of the grain boundaries by the strain and the admission of air, which causes oxide to form.

CONCLUSIONS

Considering all the facts above presented, it seems to the writer quite clear that the following conclusions are justified:

First—That nothing in the evidence so far presented is inconsistent with the theory that transverse fissures, flakes and intergranular ruptures in welds are due to the same cause, that is, films, possibly ultra-microscopic, of oxide; also that it is the only theory that appears to fit all the facts.

Second—That these films of oxide may be present in the ingot and usually are.

Third—That these films of oxide may be caused by overheating of the metal at some stage of the process of manufacture.

Fourth—That if they are caused by the presence of oxide of iron in small amounts only, such as probably causes woody steel, they can be removed by proper heat treatments, such as are stated by Dr. Giolitti and Mr. Humfrey; but if they are caused by larger amounts of oxide of iron, which would form considerable quantities of oxide film, then such heat treatment will probably not remove them.

Fifth—That it appears probable that better mill practice will result in the elimination of flakes and also of transverse fissures.

Sixth—The writer knows that such defects in welds as are visible under the microscope can be entirely eliminated by proper welding methods, which involve nothing but thorough fusion and floating all the oxide and dirt, which is clearly visible during the welding operation, to the surface. In electric welds, this procedure is more difficult because the metal is being constantly added from the electrode, and, in addition to this, the oxidizing conditions are exceedingly severe, as the metal passes through the air in the form of vapor and must become seriously oxidized. It is quite possible that ultra-microscopic films in welds may be removed by heating in a reducing atmosphere.

Seventh—The writer would suggest the examination of rails known to contain transverse fissures that have been in service by polishing and etching small sections and bending them under the microscope. He feels that such an examination would throw some additional light on the matter. He would also suggest that the same tests be applied to sound rails, to rails that show little elongation under the usual tests, to gun forgings and to other samples of steel that do not meet specifications, especially those giving low elongation. It is the writer's experience that welds properly made with good materials will, in a test piece ½ in. thick, give from 22 to 30 per cent elongation in the weld; while welds containing oxide films, though invisible, will give an elongation of from 2 to 10 per cent. The same low elongation appears to be characteristic of flaky steel and defective rail material.

Rochester, N. Y.

[EDITOR'S NOTE—In fairness to Mr. Miller, we wish to point out that his conclusions and those set forth in CHEMICAL & METALLURGICAL ENGINEERING, Aug. 1, 1919, p. 145, were arrived at by each writer in an entirely independent manner, and in fact Mr. Miller's manuscript antedates the one published Aug. 1.]

Wood Alcohol—Co-operative Caution

BY CHARLES BASKERVILLE

Chairman, Committee on Occupational Diseases, American Chemical Society

UNSCRUPULOUS persons have been selling mixtures containing wood alcohol, as such, or ethyl alcohol denatured with wood alcohol, as beverages. Co-operation of the chemical profession is sought to minimize this infraction of the law.

During the penumbra of prohibition the word alcohol has exercised a weird and unfortunate influence, oftentimes through failure to appreciate the significance of such qualifying words as "wood," "methyl," and "denatured." Numerous cases of blindness and even death have resulted through ignorance or the infamy referred to. The Commissioner of Internal Revenue has as a result issued the following notice:

> To the Collectors of Internal Revenue and Revenue Agents in Charge:
>
> T. D. 2914, issued today and showing additional matter to be affixed to containers of completely denatured alcohol, is called to your especial attention.
>
> Reports recently received in the Bureau establish that completely denatured alcohol is being used extensively for bathing and rubbing purposes. This is contrary to the law and regulations, and such uses cannot be tolerated, as the completely denatured alcohol is highly injurious to the skin and animal tissue.
>
> It is also established that completely denatured alcohol is being sold by irresponsible dealers under circumstances as to assure them that it is being used for beverage purposes. Where it is so used for any length of time blindness inevitably ensues, and the continued use can only result in death.
>
> Collectors should use every means at their disposal to make known to the public the dangers of either external or internal uses of completely denatured alcohol. Wherever collectors or revenue agents in charge hear of a misuse of completely denatured alcohol, a most thorough and careful examination should be made immediately and all the facts fully reported to the Commissioner for the infliction upon the responsible parties of the ultimate penalties provided by law.
>
> In view of the grave and extended abuses of the use of completely denatured alcohol reported, it is deemed necessary to print upon the labels affixed to wholesale and retail packages a further and more specific warning as to its use than is shown on the present required label.
>
> In addition to the present matter on the labels there will be required on all new labels hereafter the printing, in large letters in red ink, under the skull and bones symbol, the word poison, and at the bottom of the label there will be printed the following statement:
>
> > "Completely denatured alcohol is a violent poison. It cannot be applied externally to human or animal tissue without seriously injurious results. It cannot be taken internally without inducing blindness and general physical decay, ultimately resulting in death."
>
> Until the present stocks of labels are exhausted, this additional matter may be affixed to the containers on a separate label pasted above the present required label.

We chemists know that we daily handle poisons of various kinds, many far more dangerous than wood alcohol, and there are comparatively few evil results from their handling and use. People do not drink them. The medical profession administers daily to patients many substances that are poisons except in the minute doses given. But in the case of alcohol, the "kicker," in drinks of quondam familiar kinds, means just that one desired fluid, hence attendant danger. We should do all in our power to protect those who use and some likely to abuse this important chemical and thus incidentally avoid lurid appeals with consequent hampering legislation.

College of the City of New York.

An Improved Orsat Apparatus for Gas Analysis [*]

BY G. W. JONES[†] AND F. R. NEUMEISTER[‡]

IN RESPONSE to many queries regarding apparatus used at the present time by the Bureau of Mines for general gas analysis, this article is being published with the hope that some of the difficulties now being encountered by those who have had occasion to do gas analysis may be overcome. The authors do not claim originality for the apparatus described other than the few refinements indicated. The apparatus originally designed by Orsat was modified by Burrell and Oberfell,[1] using Jager's copper oxide method for removing hydrogen and carbon monoxide. In this paper especial emphasis is laid on the general plan of wiring, the supports for raising and lowering the burette leveling bulb and adjustment of same, the adjustable brackets for supporting the pipettes and the method of illumination to aid in bringing the reagents to the marks.

It is assumed that the reader is familiar with the general procedure of gas analysis; therefore this part will be described but briefly. The sample of gas is drawn into the burette *c* by turning cocks *d* and *e* to connect with *f*, the point where the sample communicates with the apparatus. Stopcock *d* is then turned to connect with the compensator of Petterssen type, modified by Gregg[2], as shown in the drawing, Fig. 1. By raising or lowering the leveling bulb the mercury in the compensator makes contact with the platinum wire and lights the lamp *L*. The volume of gas is then read, *d* and *e* are turned to connect with the Orsat apparatus, and the carbon dioxide, unsaturated hydrocarbons and oxygen are removed successively by passing the gas into the pipettes *k*, *l* and *m*, respec-

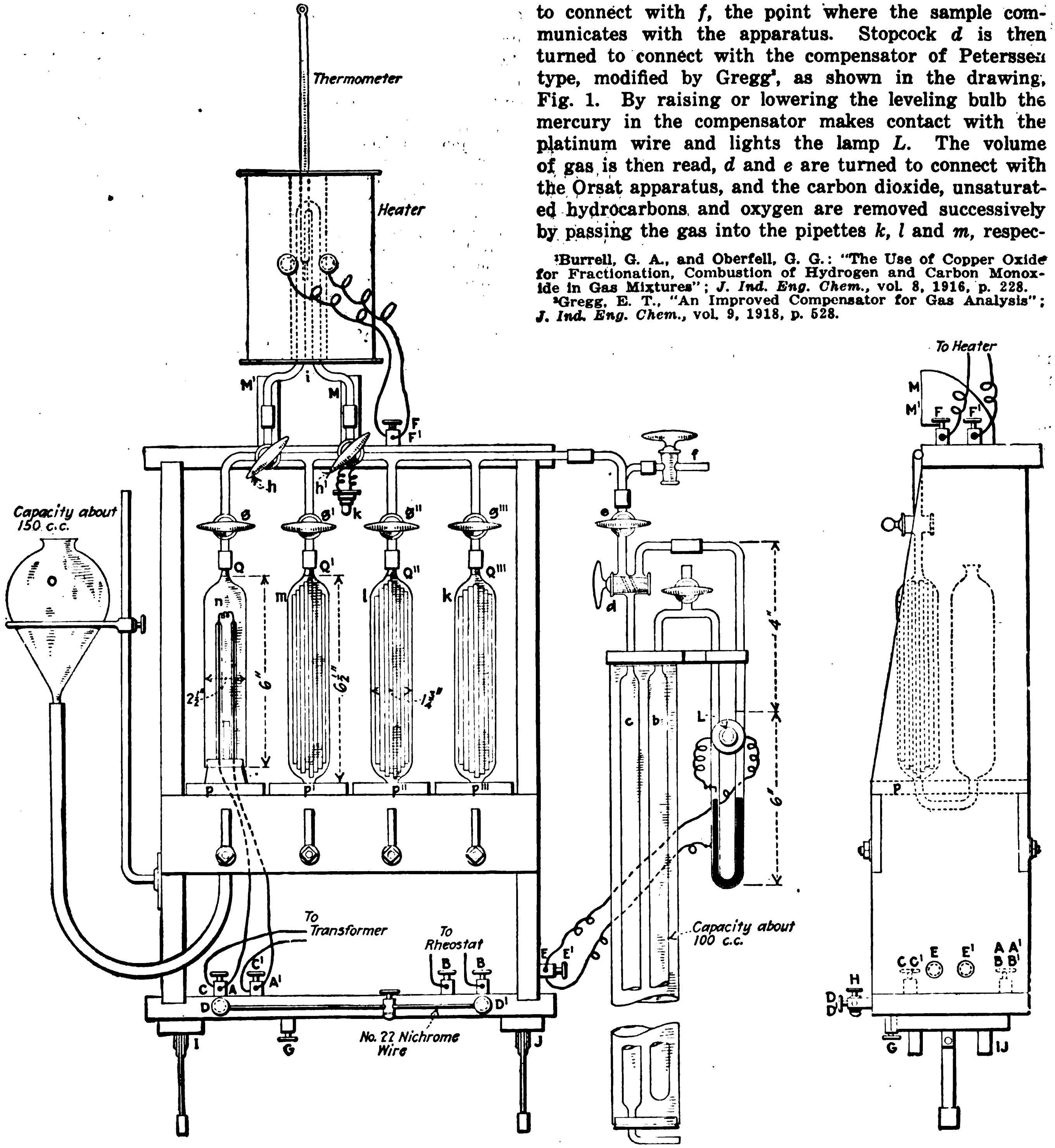

Thermometer
Heater
M'
i
M
F
F'
h
h'
k
f
e
g
g'
g''
g'''
Q
Q'
Q''
Q'''
n
m
l
k
d
Capacity about 150 c.c.
o
6"
6½"
2½"
1¾"
4"
6"
L
c
b
p
p'
p''
p'''
To Transformer
To Rheostat
C
C'
A
A'
B
B
E
E'
D
D'
Capacity about 100 c.c.
No. 22 Nichrome Wire
I
G
J
To Heater
M
M'
F
F'
C C'
E
E'
A A'
B B'
H
D
D'
G
IJ

FIG. 1. GENERAL ELEVATION OF IMPROVED ORSAT APPARATUS

tively containing potassium hydroxide solution, fuming sulphuric acid and sodium pyrogallate solution. The contraction is read after passing into each reagent, by the usual method of compensation.

---

[*] Published by permission of the Director of the Bureau of Mines.

[†] Assistant physical chemist, Bureau of Mines.

[‡] Junior chemist, Bureau of Mines.

[1] Burrell, G. A., and Oberfell, G. G.: "The Use of Copper Oxide for Fractionation, Combustion of Hydrogen and Carbon Monoxide in Gas Mixtures"; *J. Ind. Eng. Chem.*, vol. 8, 1916, p. 228.

[2] Gregg, E. T., "An Improved Compensator for Gas Analysis"; *J. Ind. Eng. Chem.*, vol. 9, 1918, p. 528.

At the beginning of the analysis electrical connections to the heater are closed and all series resistance cut out so as to raise the temperature quickly to the desired point. The heater will reach 300 deg. C. in about the time it takes to reach the point in the analysis where hydrogen and carbon monoxide are removed. The heater is next lowered over the copper oxide tube and rests on the supports *M, M'*. The gas is passed slowly from the burette through the copper oxide tube and down into the combustion pipette *n* by way of the stopcocks *h, h'* and *g*. The flow of gas is regulated by a pinch clamp to a rate of about 10 cc. per min. Three passes each way are usually sufficient. The heater is then raised and the copper oxide tube is cooled by a compressed air blast to room temperature. The mercury in *n* is brought up to the mark *Q* and the contraction read. This contraction equals the hydrogen in the sample.

Then the gas is passed into the potassium hydroxide solution in pipette *k* several times and once through the copper oxide tube to sweep out the remaining carbon dioxide. This resulting contraction equals carbon monoxide.

The residual gas is then stored in the potassium hydroxide pipette *k* and a definite volume of oxygen drawn into the burette and measured, the amount depending upon the gas being analyzed. Should this be a natural gas, and 30 cc. of residual gas be present, about 100 cc. of oxygen will be necessary. After having measured the oxygen, it is passed through the copper oxide tube and thence into the combustion pipette *n* and stored at atmospheric pressure by adjusting the leveling bulb *O*. Stopcock *g* is now closed and the gas in the potassium hydroxide solution is drawn back into the burette *C*. The platinum wire in *n* is connected electrically through the transformer and the nichrome resistance wire *DD'*, as will be more fully explained later, and raised to a desired temperature by means of the sliding contact *H*. The flow of gas is regulated by a pinch clamp and is fed in very slowly to prevent explosions. It is passed directly into the combustion pipette without going through the copper oxide tube. A cooling blast of compressed air is played upon the pipette to prevent breaking. After the gas is completely burned, the electric current is broken and pipette *n* cooled to room temperature, the gas is drawn back into the burette *c* and read, then passed into the potassium hydroxide solution and read again, then burned a second time to insure complete combustion, measured, and passed into the potassium hydroxide again and read. From the figures for total contraction and carbon dioxide produced, the two predominating hydrocarbons present can be calculated by the usual formulas. Nitrogen is always determined by difference.

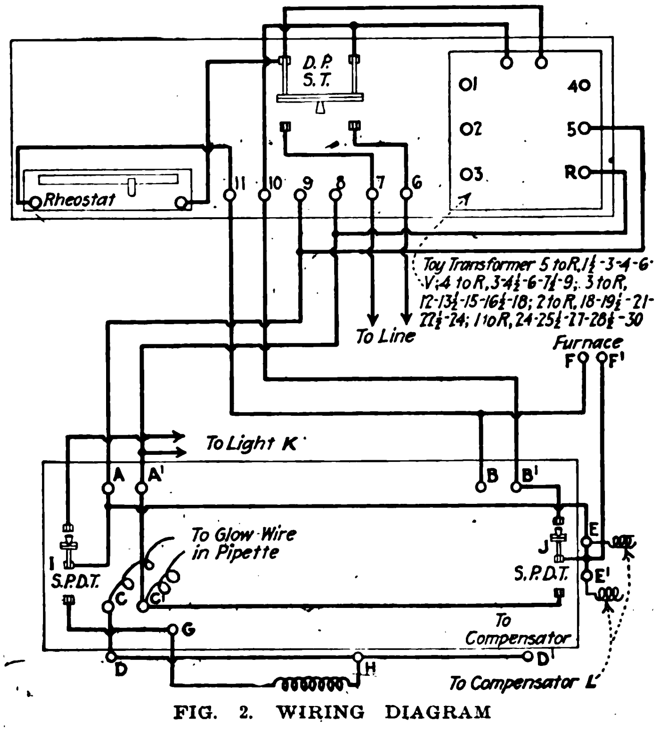


FIG. 2. WIRING DIAGRAM

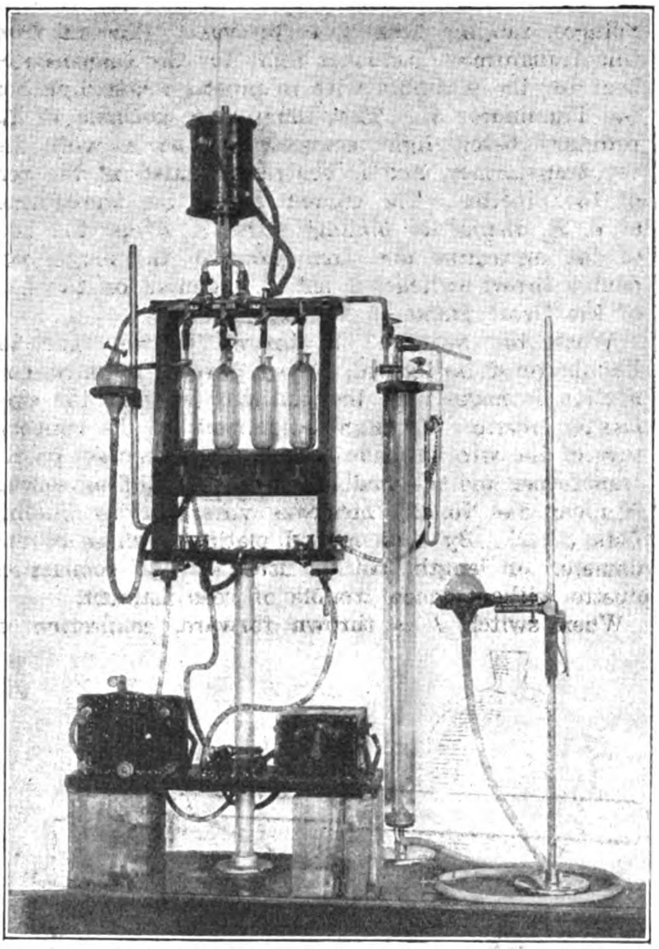


FIG. 3. ASSEMBLED GAS ANALYSIS SET

This is the general procedure for analyzing gases containing carbon dioxide, unsaturated hydrocarbons, oxygen, nitrogen, carbon monoxide, hydrogen, methane and ethane, or for gases containing part of the above constituents as natural gases.

ELECTRICAL CONNECTIONS

The source of current used is 110 volts a.c. A toy transformer and a lever type resistance box are both mounted as a unit as shown in the wiring diagram, Fig. 2. Current from the mains enters the binding posts 7, 6, thence to the switch marked *D.P.S.T.* Here the current branches, part going to a toy transformer of 150-watt capacity and having a variable voltage, ranging from 2 to 30 volts. Current from this transformer furnishes light for the compensator, heat for the platinum wire in pipette *n* and light for the illuminator *K*. This illuminator consists of the ordinary 6-volt light connected in series with the toy transformer, and is centrally located in the rear of the pipettes. The current leaves the transformer at 5, *R*, thence to binding posts *A A′* at the base of the apparatus and from here to the single pole double throw switches *I* and *J*, mounted on the base of the Orsat frame in Fig. 3.

When the switch *I* is thrown to the rear the illuminator *K* is lighted. When thrown forward, connection is made with the platinum wire in the combustion pipette. A rough adjustment of the temperature of the wire is made by the sliding contact on the transformer and the final adjustment by sliding contact *H* along the No. 22 nichrome wire held by binding posts *D, D′*. By this method platinum wires of any diameter or length can be used in the combustion pipette without much trouble of readjustment.

When switch *J* is thrown forward, connection is made with the compensator *L*, and when to the rear, with the heater for the copper oxide tube. In this manner the switches are easily accessible by the analyst and low voltage current is used for all but the heater.

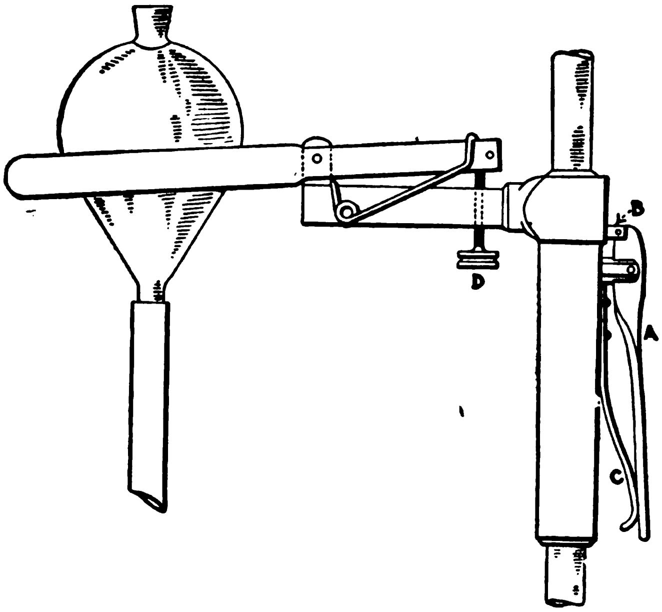


FIG. 4. ADJUSTABLE MERCURY BULB SUPPORT

The copper oxide tube heater, using 110 a.c., is made by taking 40 ft. of No. 22 nichrome wire and winding in the form of a helix. This in turn is wound over a collapsible wooden mandrel protected by a layer of asbestos paper. After the helix of nichrome wire is evenly adjusted over the mandrel, a mixture of calcined magnesium oxide and sodium silicate is made into a thick paste. Thorough mixing in a mortar and using well-calcined magnesium oxide is very necessary; otherwise the furnace will crumble after being in use for a short time. This paste is worked in very carefully between the coils of wire, then wound with a layer of asbestos rope, more paste, asbestos rope and so on until the walls are at least ½ in. thick. The heater is then covered with asbestos paper, the ends protected with "transite" boards and the terminals of the coils drawn out through the asbestos paper and "transite" board and fastened with binding posts. The furnace is then dried for several hours at 100 deg. C., after which it is ready for use.

PIPETTE SUPPORTS

All the pipettes are supported by adjustable brackets *p*, so that pipettes of any length can be used, or easily removed for cleaning or renewal of reagents.

Fig. 4 shows a device for raising and lowering the mercury bulb connected with the gas burette. By exerting pressure on the lever *A* with the hand, the friction pin *B* is released from the rod supporting the bulb, when the support can be raised or lowered at will. When the pressure is removed spring *C* forces the friction pin *B* into contact with the supporting rod and holds the bulb firmly at that elevation. Final adjustment is made by turning setscrew *D* with the thumb and forefinger, thus raising and lowering the bulb only a very small distance. In making an analysis the solution in the pipette is brought approximately to the correct point when the bulb is clamped and the solution brought exactly to the mark by final adjustment with the setscrew *D*.

It has been suggested that quartz should be used for the copper oxide tube and combustion pipette. The Bureau has had copper oxide tubes and combustion pipettes made of pyrex glass in steady use for over two years without breaking. It is understood that when burning the gas must be fed into the oxygen instead of the oxygen into the gas, also that the pipette must be kept cool by compressed air or by some other means, when burning gases containing a large amount of combustibles—especially those of high molecular weight like ethane and propane.

Copper oxide is hydroscopic, and when an apparatus has not been used for some time it is necessary to give the tube a preliminary treatment by passing air through it for some time at a low temperature in order to drive out the moisture. When the copper oxide has become somewhat reduced, which is indicated by the red color, compressed air or oxygen is passed over the mass heated to a temperature of about 250 deg. C. to revive it.

Laboratory of Gas Investigation,
Bureau of Mines,
Pittsburgh, Pa.

Improvement in Sheet-Ground Region

A marked revival in zinc production in the environs of Miami, Oklahoma, has occurred since the low-price level attained in July, when only about 85 properties were able to produce at the then ruling price of about $35. Perhaps half as many mills have resumed, in response to an increase in price of zinc concentrates to $55, which is regarded as being about as much as the present spelter market can carry. Shortage of labor and prospecting rig helpers has prevented a large expansion in tonnage, however, many men having gone into the harvest fields or the Texas oil regions. While a good shoveler working "by the can" earns $1 an hour, mill men and mechanics have not enjoyed a correspondingly fancy rate. The operators feel that lower costs of living are necessary in order that their employees may be satisfied and labor stabilized, and a fuller resumption of business activities in the United States before the lead and zinc industry, either in the production of mineral or the manufacture of metal, can assume a healthy and profitable condition.

Radiant Resistor Furnace*

The Author Describes His Radiant Resistor Furnace for the Distillation of Low-Grade or Scrap Zinc—Best Results Obtained With a Current of Approximately 845 Amp. at 65 Volts or 55 Kw.—With This Power the Output Was About 50 Kg. Refined Zinc Per Hour

BY F. A. J. FITZ GERALD†

IN 1905 a small laboratory furnace in which the charge was heated by means of radiant resistor was described.[1] A note about a furnace heated in a similar manner, but having an electrical capacity of 150 kw. was published in 1910,[2] and the description of another design appeared under the title of "A New Electric Resistance Furnace," in a paper given to the American Electrochemical Society in 1911.[3] This also had a capacity of 150 kw., and, like the furnace described in 1910, was designed by Thomson and FitzGerald, the object in each case being the smelting of zinc ores by the Imbert process. The furnace described in 1911 was used in experimental work and was found to be very unsatisfactory, as shown in a paper, "Note on an Unsuccessful Furnace Experiment," presented to the American Electrochemical Society in 1911,[4] but the experiments showed very clearly that the trouble was due to faulty design and construction, more particularly very imperfect heat regulation.

In 1915 the cost of high-grade zinc increased so much that experiments on the distillation of low-grade or scrap zinc appeared to be worth while, therefore Thomson, with our collaboration, designed a furnace on principles similar to those mentioned above, and this was built and operated at the FitzGerald Laboratories, several tons of refined zinc being produced.

The diagrams of Figs. 1, 2 and 3 show the construction of the furnace; Fig. 1 with the cover removed, Fig. 2 a longitudinal vertical section, and Fig. 3 a transverse vertical section. The furnace was approximately 2 meters long (6½ ft.) and the diagrams are drawn approximately to scale. The same lettering is used in all figures.

The parts of the furnace constructed of firebrick are marked *D*, and the heat insulation, which consisted of either Sil-O-Cel or the insulating brick made by the Armstrong Cork Co., is marked *A*. The furnace hearth containing the charge was made of various materials, *L*, but the most satisfactory was a carbonaceous refractory called "Vitricarbo" manufactured by the National Carbon Co. The furnace was heated by two resistors, *R*, which were made from graphite slabs which had slots cut into them so as greatly to increase the path of the current. The current is brought to the resistors by the graphite terminals *T T* and the resistors are connected in series by the graphite connector *T'*. The furnace was charged with molten zinc by means of the inclined tube *S*, the lower end of which was normally below the surface of the molten bath. Above the resistor were two diaphragms *B*. The lower one of these consisted of a set of plates laid transversely in the furnaces, each plate being one inch distant from its neighbors, thus forming a porous diaphragm. The upper diaphragm was made of 2-in. (5-cm.) carbon slabs, and it did not extend to the ends of the furnace. Thus the zinc vapors had to pass up first through the openings in the lower diaphragm and thence flowed out round the ends of the upper diaphragm, finally reaching the opening *F*, which led to the condenser. The cover of the furnace was formed of carbon slabs *C*, on top of which were the firebrick *D* and finally the heat insulating brick *A*. At *O* there was a hole in the cover into which a pyrometer tube was inserted for measuring the temperature of the zinc vapors passing into the condenser through *F*. The condenser is not shown in the diagram, but was in the form of a flat box about 100 x 50 x 7 cm. with a series of transverse baffle plates. This was provided with means for preheating, at first electrically but subsequently with a charcoal fire, since once distillation was fairly under way external heating was unnecessary.

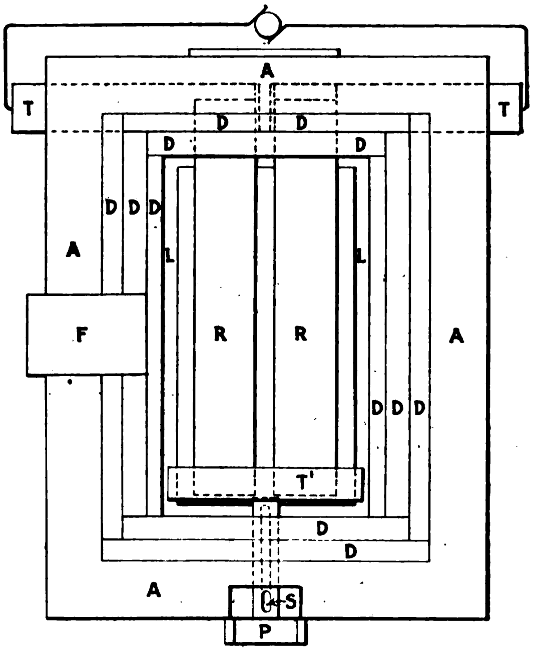


FIG. 1. FURNACE WITH COVER REMOVED

The furnace was originally designed with the idea that it would use 75 kw. or 1000 amp. at 75 volts, and turn out 45 kg. of zinc per hour. It was found, however, that the best results were obtained with a current of approximately 845 amp. at 65 volts or 55 kw., and that with this power the output of distilled zinc was about 50 kg. per hour.

From previous experimental work with zinc furnaces much experience had been gained in the problem of condensing zinc vapor, so that no difficulty was found in designing a condenser which would give liquid zinc without the production of any blue powder. There were plenty of other troubles with the condensers, mainly due to the difficulty of constructing the particular form used in such a way that it would not develop leaks. These difficulties were, however, overcome.

---

*Paper read at the meeting of the American Electrochemical Society in Chicago, Sept. 23-26, 1919.

†Electric furnace expert, Niagara Falls, N. Y.

[1] *Electrochemical & Metallurgical Industry*, vol. 3, p. 218 (Now consolidated with CHEM. & MET. ENG.)

[2] MET & CHEM. ENG., vol. 8, p. 317.

[3] *Transactions* (1911) vol. 19, p. 273, *et seq.*

[4] *Transactions* (1911) vol. 20, p. 281, *et seq.*

The method of working the furnace was as follows: When building it, before putting in the resistors, as much scrap or low-grade zinc was put into the hearth *L* as it could contain, and the construction of the furnace then finished. After starting, the current was at first kept very small so as to dry out the furnace slowly, then it was raised and more zinc from the premelter introduced through *S* until the lower end of *S* was well closed. Meanwhile the condenser was heated to a temperature slightly above the melting point of zinc. When the zinc vapor began distilling, the temperature in the condenser rose till finally it was no longer necessary to supply external heat, but instead some of the heat insulation was removed. Thereafter it was merely necessary to keep a watch on the condenser temperature and slightly adjust the air-cooling devices. The zinc was tapped from the condenser at intervals, and premelted zinc introduced so as to keep the lower end of the tube *S* closed. From time to time the residue in the furnace, consisting mainly of zinc very high in iron and lead, was tapped from the furnace at *P*.

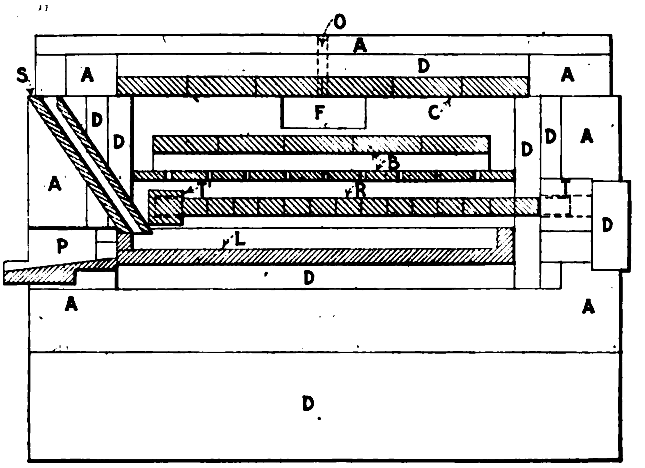


FIG. 2. LONGITUDINAL VERTICAL SECTION OF FURNACE

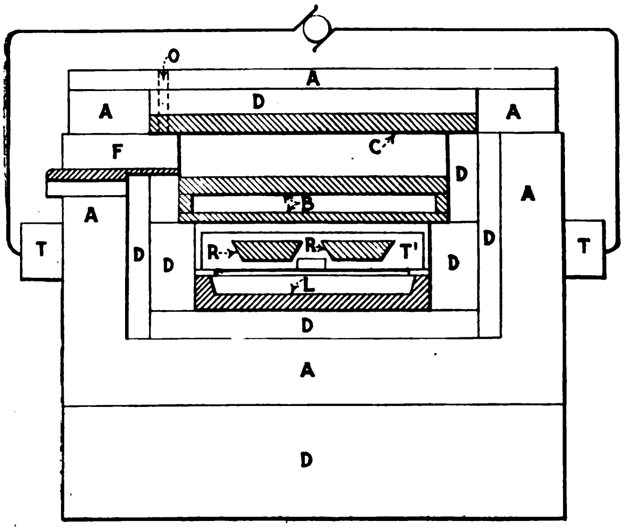


FIG. 3. TRANSVERSE VERTICAL SECTION OF FURNACE

One interesting accident which happened once or twice was the plugging up of the charging tube *S* caused by pouring in molten zinc too near its freezing point. This was cleared by making electrical contact with the bath through the tap hole at *P* and then arcing on the frozen zinc with a rod introduced through *S*.

The experimental work on the distillation of zinc ran over many months, for all sorts of investigations were made on forms of resistors, designs of terminals, various kinds of premelting furnaces, small-scale experiments on fractional distillation of zinc alloys, production of blue powder, various forms of condensers, refractory materials, heat insulators, etc. But to give an idea of the furnace's working under normal conditions, a run of 37 hours may be taken, because this will show the behavior of the furnace after starting up and also what may be expected from it with continuous running under constant conditions. Energy measurements were made at the furnace. The zinc charged into it was in the molten state, hence the figures for energy consumption do not include melting. Here are the data obtained:

Length of run	37 hr.
Average power used during distillation	55.2 kw.
Total energy for distillation	2051 kw.-hr.
Minimum temperature of zinc entering condenser	1040 deg. C.
Average temperature of zinc entering condenser	1225 deg. C.
Average temperature of zinc in premelter	550 deg. C.
Weight of zinc condensed	1558 kg. (3494 lb.)
Weight of zinc condensed per hr.	43 kg. (95 lb.)
Energy per kg. of zinc	1.29 kw.-hr.
Energy per lb. of zinc	0.59 kw.-hr.

In order to get a notion of the behavior of the furnace when it has reached normal working conditions the last 9 hr. of the run may be taken:

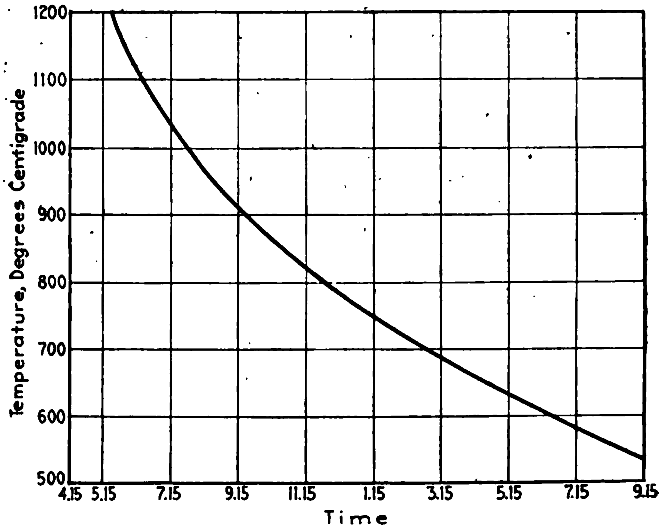


FIG. 4. COOLING CURVE OF THE FURNACE

Length of period	8.9 hr.
Average power used during distillation	54.4 kw.
Total energy for distillation	484 kw.-hr.
Av. temperature of zinc vapor entering condenser	1250 deg. C.
Average temperature of zinc in premelter	550 deg. C.
Weight of zinc condensed	455 kg. (1001 lb.)
Weight of zinc condensed per hr.	51 kg. (112 lb.)
Energy per kg. of zinc	1.06 kw.-hr.
Energy per lb. of zinc	0.48 kw.-hr.

A question that will naturally be asked is how much energy was used in premelting the zinc fed into the furnace. Unfortunately the records do not give a direct answer to this question, for much trouble was experienced with the premelter during the earlier part of the run. However, it is possible to get a fairly close approximation of what energy we used for premelting during the last 9 hr. of the run from the following data:

Weight of zinc melted	968 kg. (2130 lb.)
Energy consumed for melting	216 kw.-hr.
Energy per kg. of zinc	0.22 kw.-hr.
Energy per lb. of zinc	0.10 kw.-hr.
Weight of zinc transferred from melter to furnace,	632 kg. (1390 lb.)
Energy used to melt 632 kg. of zinc	139 kw.-hr.

Now, by referring to the figures given above for the last part of the distillation, it is found that the total energy used in producing 455 kg. (1001 lb.) of distilled zinc was 623 kw.-hr., hence:

Total energy per kg. of zinc	1.37 kw.-hr.
Total energy per lb. of zinc	0.62 kw.-hr.

It will be observed from these figures that the percentage of zinc refined by distillation in this particular experiment was only 72 per cent of the amount charged, therefore the amount of zinc which had to be premelted was greater than would have been the case had the distillation been carried further.

The curve shown in Fig. 4 is a cooling curve of the furnace.

As regards furnace troubles, the only one that amounted to anything was leaking of the hearth. This was simply due to faulty construction of the lining, a fault that was corrected by experience.

Tungsten Situation in Peru

PRACTICALLY all the tungsten ore exported from Peru is produced in the districts of Conchucos and Corongo, both situated back of the ports of Salaverry and Chimbote, the mineral being transported over the mountains on the backs of llamas and burros from the tungsten mines to the railways connecting with these two ports. Practically all mining of tungsten is done in a very primitive manner. The miners are the Indians—what are commonly known here as "cholos"—of the mountain districts. The mineral is all hand washed by the Indians.

The mining of tungsten in Peru may be considered sporadic; that is, its development depends largely upon the demand and prevailing prices in Liverpool and New York. When the price of the ore is low, little interest is manifested in its mining, and the Indians are withdrawn from the tungsten mines or holes to be occupied in the copper and silver producing mines in the same district. Fortunately during the last four years there has been a good demand for tungsten, which has favorably affected the industry.

DESTINATION OF EXPORTS

The exportation of tungsten ores from Peru during the years 1913 to 1917, with the ports of shipment, quantity and value exported, and the countries of destination, is given in Table I. It will be noted that the average exports of tungsten during the last five years are about 354 metric tons a year. Prior to the war about 60 per cent of all tungsten exported from Peru went to Germany. Since the middle of 1914 the exports have been diverted to the United States, a small quantity finding its way to Great Britain and France.

The total exportation of tungsten from all Peruvian ports to New York during the calendar year 1918, showing the points of shipment, quantity and net value, is given in Table II. The mineral shown as shipped from Callao originally came from the port of Chimbote, and that recorded as shipped from Mollendo originated in Bolivia, from which country considerable quantities are exported to the United States and some European countries.

TABLE I. EXPORTATION OF TUNGSTEN ORES FROM PERU, 1913-1917

Port of Shipment 1913	Quantity Kilos	Value	Country of Destination	Quantity, Kilos	Value
Chimbote	122,466	$36,397	Germany	151,636	$45,672
Salaverry	167,836	56,919	United States	117,469	40,701
			France	8,367	2,501
			Great Britain	12,830	4,442
Total	290,302	93,316	Total	290,302	93,316
1914					
Callao	2,940	1,395	Germany	122,508	61,831
Chimbote	71,613	34,144	United States	9,068	4,666
Salaverry	121,713	62,250	France	1,750	849
Not specified	....	63	Great Britain	26,047	12,793
			Italy	36,893	17,713
Total	196,266	97,852	Total	196,266	97,852
1915					
Callao	15,902	13,698	United States	288,527	209,857
Salaverry	177,266	134,224	France	7,802	8,039
Chimbote	145,965	101,581	Great Britain	42,804	31,607
Total	339,133	249,503	Total	339,133	249,503
1916					
Callao	9,688	12,472	Bolivia	200	484
Chimbote	188,612	421,977	United States	517,252	1,066,507
Puno	300	484	France	6,380	5,889
Salaverry	325,332	637,947	....	....	....
Total	523,932	1,072,880	Total	523,832	1,072,880
1917					
Callao	1,286	1,155	United States	417,336	485,016
Chimbote	152,698	182,446	....	....	....
Salaverry	263,352	301,415	....	....	....
Total	417,336	485,016	Total	417,336	485,016

TABLE II—EXPORTS OF TUNGSTEN FROM PERU TO NEW YORK, 1918

Port of Shipment	Gross Weight, Kilos	Net Weight, Kilos	Tungsten Contained, Kilos	Commercial Value	Freight Value	Net Value
Salaverry	178,959	176,487	109,860.6	$243,812	$19,742	$224,070
Chimbote	55,669	54,885	33,439.2	74,206	4,102	70,104
Callao	11,030	10,780	7,478.2	16,595	907	15,688
Mollendo	904	891	534.6	1,186	43	1,143
Total	246,562	243,043	151,312.6	$335,799	$24,795	$311,004

COST OF PRODUCTION AND PRICE QUOTATIONS

It is difficult to ascertain the cost of the production of tungsten delivered at the coast, as it depends upon the distance the ore is transported by llamas and burros, the proximity of the mines to the railways, and the wages paid. However, the cost of mining and delivering the concentrates at the seacoast should be insignificant in comparison with the prices received during the war for the ore, particularly when it is known that the average Indian miner works for about $1 a day. The price received for the ore is regulated by the prevailing price of the mineral markets of Liverpool and New York. Tungsten is shipped in concentrates of from 58 to 60 per cent. The owners of the mineral in Peru generally arrange with the buyers to draw against each shipment up to 70 per cent of its value.

The price of tungsten in June, 1919, was about $10 a unit of 60 per cent concentrates. Before the war it was about $7; during the war the price reached the maximum of $26 a unit.

War Department Record of Government Purchases During War

Mr. W. L. Pollard, chief of the Historical Branch of the Purchase, Traffic and Storage Division of the War Department, is sending out a questionnaire to all firms which have supplied the U. S. Government during the war. This document covers the nature, value and quantity of materials and details of production, together with new processes, changes in operation, amount of capital investments added, labor difficulties, replacement by female labor, and other data necessary to obtain complete record of accomplishments of this branch of the country's activity.

Substitute Metals in Electrotechnical Industries in Germany*

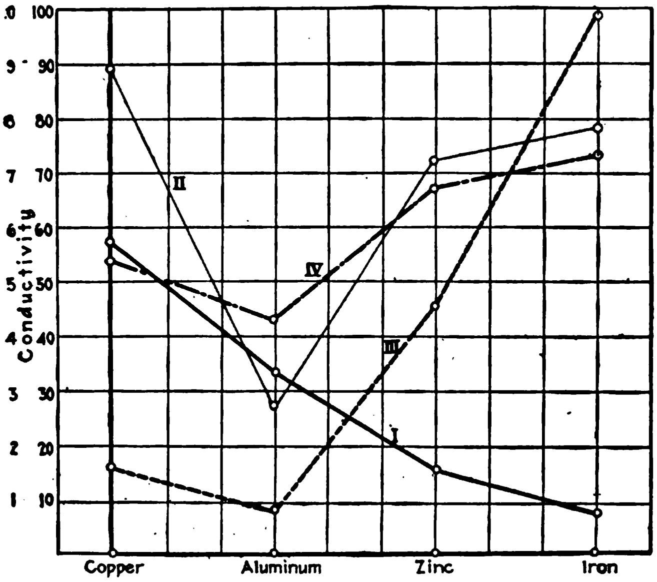
THE most important of these substitutions is the use of aluminum in manufactures formerly made of copper. Before the war it was almost universal practice in Germany to use exclusively copper for bodies which had to conduct electric current. Germany used before the war about 200,000 tons of copper per year, not including copper exported in finished articles. Of this quantity, scarcely 10 per cent was furnished by her own mines.

At the beginning of the war very great quantities of copper were used for munitions, submarine boat motors, and other important war material; at the end of 1914 the necessity of substitutes for the fast-vanishing supply of copper was clearly seen. The principal substitutes are iron, zinc and aluminum, all of which have lower electrical conductivity than copper; therefore, to avoid great losses of electric energy, larger cross-sections must be used, entailing greater cost of metal and of construction to support it.

The accompanying diagram gives at a glance the relative values and usefulness of copper, aluminum, zinc and iron as electrical conductors. Line I shows the relative electrical conductivity of the four metals. Line II shows the specific gravities. Line III shows the relative weights of metal necessary to use for a conductor of a given length in order to get equal current carrying power (conductance); these ordinates are made proportional to I divided by II. If the points on line III are multiplied by the price of the metal per kilo, line IV results, which shows the relative costs of lines of equal length and the same conductance, at present prices for plain wire or rod metal. It is seen that aluminum needs to be only about one-half the weight of copper, and costs, at present prices, about four-fifths as much. These relations will change with the market prices. While the conductivity is one of the most important characteristics to be considered in this comparison, it is not the only one which influences the use of these metals for electrical conductors.

Iron has the advantage of great mechanical strength, which gives it many advantages for suspended freely-hanging conductors. Its conductivity is so small, however, that its strength can be of importance only where electrical energy losses are of secondary importance. A still more important question is the magnetic qualities of iron, which frequently forbid its employment in machines, and cause too great losses by the energy consumed in magnetizing and de-magnetizing it, where alternating current or pulsating direct current is used. Iron was therefore used during the war in a very few places for conducting the current, such as in relatively short high-tension lines, in some special switches for small amperage, and for collector brushes on small direct-current machines. In the future almost all these will be replaced by copper or aluminum, with perhaps the possible exception of the above-mentioned short high-tension lines as long as these are used as branch lines to separate consumers and are not in the circuit of the principal line.

Zinc was much spoken of as a substitute metal in the early days of the war. It has very little mechanical strength, and therefore is unsuited for freely-suspended conductors or similar purposes. Zinc wire insulated with rubber and cotton was quickly put to use as installed conductors in buildings, for light and power purposes. Attempts were made to alloy it, in order to increase its mechanical strength, but it was found that only the purest zinc would stand the requirements necessary for installing such wire in buildings. After overcoming these difficulties, many thousand kilometers of such wire was laid, without any difficulties arising which could be ascribed to the zinc. In such use it must be observed that the zinc is not installed at low temperatures, say under 5 deg. C. (40 deg. F.), that it will not stand high temperatures, such as 80 to 100 deg. C. (176-212 deg. F.), and must not be subjected to any continuous vibration. Under such adverse conditions it becomes brittle, crystallizes and forms a discontinuous mass which cannot carry the current. At first zinc was also used for windings of dynamos, transformers, coils for various apparatus, etc., and apparently with success, but difficulties arose so frequently, because of the above-noted properties, that even during the course of the war such applications were given up. On a large scale, zinc is now used only in insulated installed wiring, but even this use will probably be abandoned to copper or aluminum.



RELATIVE VALUES AND USEFULNESS OF COPPER, ALUMINUM, ZINC AND IRON AS ELECTRICAL CONDUCTORS

I. Relative electrical conductivity. II. Specific gravities. III. Conductance. IV. Product of conductance and price of metal per kilogram.

Aluminum is the metal which has mostly replaced copper during the war, and which will stand alongside of copper in the future. In this replacement, however, other questions than the specific properties of aluminum must be considered. At the beginning of the war there was no aluminum works in Germany and only imported aluminum ingots were available. This crude metal came from Switzerland, which in turn obtained the aluminum oxide or alumina, from which the metal is extracted, from France. During the first part of the war the Germans were able to obtain all the aluminum required, but later the supply diminished so that they felt the necessity of

---

*Abstracted from *Das Technische Blatt*, May 3, 1919, p. 24. A. Feckinghaus, "Ersatzstoffe in der Elektrotechnischen Industrie."

building their own reduction plants. This became the more practicable since meanwhile alumina was being manufactured in Austria, Galicia and even in Germany, thus providing the raw material for the industry. The cost of production was immaterial, since the metal had to be made as a war necessity. Switzerland, with its cheap water power, could naturally produce cheaper, but the large amount of power necessary had to be found in Germany. The plants were therefore placed near the fields of brown coal (lignite), which is a relatively cheap fuel, useful alike for manufacturing alumina from the raw minerals and for raising steam to provide the power necessary for the electrical reduction of the alumina to metal. Today the German output of aluminum is already important, although the works are not yet all completed. It is naturally of the greatest importance for Germany to reduce as far as possible its need of importing copper, and to produce its substitute, aluminum, from German raw materials in German factories. It is estimated that it will be possible for them thus to shut off permanently one-third of the former importations of copper, corresponding to a value of several hundred million marks yearly. But since enormous stocks of copper have accumulated in America, which after the war will be dumped on the German market at low prices, it will be necessary that their domestic aluminum works be able to compete with cheap American copper.

Although aluminum has only one-third to one-fourth[1] the mechanical strength of copper, yet it is strong enough to be used extensively in all kinds of bare conductors. Its use as insulated wire installed in buildings has already been alluded to. It is also used in lead-covered cables which are buried in the ground, particularly for the smaller cross-sections. Three-phase motors and transformers, excepting the quite small types, are exclusively provided with aluminum windings. Direct-current motors have aluminum magnet-windings; it is also used in collectors and a large number of apparatus, instruments and installation equipment.

A difficulty is produced in some places by the layer of oxide which forms on aluminum, a thin film of aluminum, which gives poor contact at the binding posts. It can also not be welded or soldered easily. Special methods are therefore used to make secure and durable contacts or joints, but these are not sufficiently simple to enable aluminum in all cases to replace the much more easily soldered copper. The armature windings of direct-current generators, for instance, have been made of aluminum, but more recently the makers have returned to using copper, since the many connections of the armature coils to the collector sheets give trouble.

NEW RULES FOR THE USE OF METALS

The German Electrotechnical Union has recently set forth new rules concerning the use of copper, aluminum, etc., based on experience collected during the war; these rules must be observed, under penalty. According to these rules, the above-mentioned uses of aluminum are, for the greater part, to be continued, since experience has shown that this can be done without detriment to the quality of the manufactured object. A large part of the purchasers of electrical equipment have still a certain mistrust concerning the use of aluminum, for instance in three-phase transformers and motors, and insist on having only copper. For this reason, ten and twenty-year-old machines are being sold at extraordinarily high prices simply and only because they are wound with copper. This fact tends to increase the mistrust of the purchasing public against aluminum, which sentiment is skillfully nurtured by the people having such old machines to sell, in order to obtain still higher prices. But the quality of the machines now being made with aluminum is so high that this prejudice is certain to subside and the general use of aluminum for such purposes may be taken as certain, since it is in reality a complete and satisfactory substitute.

The war has therefore been fruitful to the electrotechnical industries of Germany, in that it has taught by sheer necessity how to manufacture as independently as possible of importations from foreign countries, and using only the domestic raw materials. The commercial balance sheet will thus gain a permanent advantage.

The Proposed Belgian Steel Trust

The proposed Belgian steel plant combination is discussed by the London *Iron and Coal Trades Review*. The origin of the scheme is attributed to M. Trasenster, general director of the Ougrée-Marihaye Co., who recently invited representatives of the works to attend a meeting to consider the scheme. The works represented were the Cockerill Co., Thy-le-Château, Sambre and Moselle, Angleur, Espérance Longdoz, Athus-Grivegnée, Usines Métallurgiques du Hainaut, Monceau Saint-Fiacre, Forges de Clabecq, La Providence, Châtelineau and Boel. The meeting is reported to have approved the plan in principle, although two of the most important works are said to have hitherto held aloof.

The proposition is that the combination should take over the assets and liabilities of the constituents, and that the share capital of 300,000 francs be allotted to the works in proportion of the respective values of their undertakings. In order to reach a basis of valuation a meeting of the financial representatives of the works has just been held at the Société Générale, Brussels. After discussion the following points were agreed to as the basis: Ascertainment of the stock exchange value of the shares on June 30, 1914, ascertainment of the profits in the 30 months immediately preceding July 31, 1914, and inventory of the buildings, mine fields, materials, etc. In this connection the representatives of the Ougrée and Providence companies stated that it was impossible at present to ascertain the future value of the iron-ore mines and their investments in mines which they possess in Luxemburg and France, and the Angleur company associated itself with this objection. The three companies, however, eventually agreed that the value of their iron-ore rights should be determined by experts.

The managing director of the Ougrée-Marihaye Co. stated recently that, if the amalgamation was carried out, each works would specialize in the product for which it was best adapted and thus be in a position to lower the producing costs and selling prices without lessening the profits.

---

[1] It is stronger than stated, up to two-thirds to three-fourths.—Abstractor.

Recent Chemical and Metallurgical Patents

British Patents

Complete specifications of any British patents may be obtained by remitting 25c. each to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Sulphonic Acids.—Sulphonic acids are isolated from crude sulphonation products in the form of salts of divalent or trivalent metals, such as magnesium, aluminum, iron, nickel, cobalt, cadmium, or zinc, by adding to the crude product a soluble sulphate of such metal in amount not exceeding 5 per cent in excess of the theoretical amount for double decomposition, the strength of the sulphuric acid in the mixture being maintained throughout at 30 to 50 per cent; the precipitated salt is filtered and washed with a cold saturated solution of the sulphonic acid salt obtained in the previous operation; part of the filtrate is neutralized with metal, oxide, hydroxide, or carbonate, and used to provide the metallic salt for the next operation, while the rest constitutes recovered sulphuric acid. The process may be applied to the separation of two or more mixed sulphonic acids obtained by sulphonation. Examples are given of the isolation of benzene sulphonic acid as magnesium salt, the separation of phenol-p-sulphonic acid as zinc salt, and the separation of m-xylenesulphonic acid as magnesium salt. (British Patent 14402—1915. A. Lapworth and H. N. Morris, both in Manchester; May 14, 1919.)

Explosives.—Methods of preparing explosives which consist in the use of dicyandiamidine perchlorate alone or mixed with other ingredients as blasting and military explosives and in methods of manufacturing the dicyandiamidine perchlorate. One example of such explosives contains dicandiamidine perchlorate 69 per cent, sodium nitrate 29 per cent and wood meal 2 per cent. Another example contains dicyandiamidine perchlorate 10 per cent, trinitrotoluene 10 per cent, and ammonium nitrate 80 per cent. One method of manufacturing dicyandiamidine perchlorate is to convert dicyandiamide into dicyandiamidine sulphate, and then add to a solution of this a solution of barium, strontium or calcium perchlorate. Another method of manufacturing is to convert dicyandiamide into dicyandiamidine hydrochloride by heating with hydrochloric acid, and then add a hot concentrated solution of sodium perchlorate; this reaction also takes place at ordinary temperatures. (British Patent 14706—1915. W. Rintoul, E. G. Beckett and Nobel's Explosives Co., Ardeer factory, Stevenston, Ayrshire; May 14, 1919.)

Explosives.—Method of making explosives by adding 82 parts of ammonium perchlorate or 83½ parts of potassium perchlorate to about 18 or 16½ parts respectively of melted paraffine wax. After cooling, the mixture may be pressed into any shape desired or may be used in the form of powder or granules. (British Patent 14932—1915. Perchlorate Safety Explosives, Ltd., and H. Harris, London; May 14, 1919.)

Explosives.—Method of making explosives by mixing ammonia perchlorate with calcium or barium silicide, to which may be added sodium or potassium nitrate and other ingredients such as paraffine wax, wood meal and aromatic nitrohydrocarbons, for example trinitrotoluene. An example contains 75 per cent of ammonium perchlorate, 15 per cent of calcium silicide, and 10 per cent of paraffine wax. (British Patent 10865—1915. E. I. Pronk and F. E. W. Bowen, both in London; May 14, 1919.)

Cracking Hydrocarbons.—High boiling hydrocarbon oils and residues are converted into low boiling hydrocarbon by bringing them in the liquid state into contact with pumice stone or sandstone heated to 500-800 deg. C. in a closed retort, and condensing the resulting vapors. The vapors are removed by a pump and are fractionally condensed under pressure, for example 16 atmospheres. Viscous hydrocarbons, such as tars, are preheated to increase their fluidity. In treating tar for the production of toluol, a temperature of 750 deg. C. is employed. Liquid fuel of the nature of petrol is produced from fuel oil at about 550 deg. C. (British Patent 10981—1915. J. G. Robertson, Partick; and J. Nilson and Petrol Patents, Ltd., Glasgow; May 14, 1919.)

Ketones.—Acetone and di-ethylketone are prepared by passing the vapor of acetic or propionic acid over manganous oxide at about 350 deg. C. The manganous oxide is distributed or supported so as to present an extended surface and remain porous. This may be effected by boiling pumice in a solution or suspension of manganous acetate or carbonate, drying, and heating until the oxide is formed. (British Patent 14085—1915. N. V. Sedgwick and B. Lambert, both in Oxford; May 14, 1919.)

American Patents

Complete specifications of any United States patents may be obtained by remitting 10c. each to the Commissioner of Patents, Washington, D. C.

Basic Sulphate of Zirconium.—It has been proposed to produce zirconium oxide by first preparing a zirconium oxychloride and treating this with a definite amount of sulphuric acid, the mixture being allowed to stand in the cold or at about 40 deg. C., when a basic sulphate of zirconium having the composition $3ZrO_2.2H_2SO_4$ separates in small prisms which are free from iron and titanium. This basic sulphate of zirconium can be converted to zirconium oxide by any well-known method. The method is, however, objectionable in that the time required for the precipitation of the basic sulphate of zirconium extends over a great number of days. Further, the precipitation is never complete, less than 75 per cent precipitating out in two weeks. Edward J. Pugh of Glenside, Pa., uses the following modified procedure to obtain a better yield in less time: A quantity of zirconium oxychloride containing 100 g. of zirconium oxide is dissolved in 3 liters of water; this solution is acidified with hydrochloric acid and an addition of 48 g. of sulphuric acid is made. So long as the solution remains cold, little or no precipitate is formed, but upon heating a white crystalline precipitate is formed having the composition $5ZrO_2.3SO_3.13H_2O$. The zirconium is thus precipitated as a new basic sulphate free from iron, titanium and silicon and capable of ready conversion to pure zirconium oxide in any well-known manner. (1,316,107; assigned to Pennsylvania Salt Mfg. Co.; Sept. 16, 1919.)

Cellulose Solvent.—Cellulose is soluble in mixtures of hydrochloric, sulphuric and phosphoric acids. For example: 1 kg. of air-dried cotton is kneaded with about 6 kg. of a mixture of hydrochloric acid (35 per cent HCl) 9 parts, sulphuric acid (99 per cent) 0.5 part, and phosphoric acid (85 per cent) 2 parts, all by weight; the solution is cooled to prevent escape of HCl. A thick viscid mass results, which may be clarified and then forced through nozzles into a suitable coagulating bath, as water, dilute acids, solutions of various salts, solutions of colloids and various other media such as alcohol, etc. The solution may also be allowed to hydrolyze and the glucose thus formed may be recovered or fermented to alcohol. (1,315,393; Zeno Ostenberg of San Jose, Calif.; Sept. 9, 1919.)

Production and Use of Aminocymene as a Dye Intermediate.—The so-called "spruce turpentine," which is a by-product from the relief liquor collected in the process of making sulphite pulp from spruce chips, contains cymene, terpenes, H_2O and dissolved SO_2. Chester E. Andrews of Pittsburgh proposes the following process for recovering and utilizing the cymene. Spruce turpentine is treated with sufficient quicklime to combine with and precipitate the H_2O and SO_2 present. After filtering, the liquid contains approximately 75 per cent cymene, the remainder being terpenes. This mixture is dissolved in 98 per cent sulphuric acid and nitrated with mixed acid at 0 deg. C. The product is poured into cold water, the oily layer separated and washed with dilute alkali solution. The principal ingredient is mononitrocymene (1-methyl-2-nitro-4-isopropylbenzene). This is easily reduced to the corresponding amino compound, which may be purified by agitating with dilute sulphuric acid, forming the sulphate of the amine. This is not volatile with steam and may thus be separated from the impurities (terpenes) by steam distillation. The sulphate is then decomposed by alkali and the pure aminocymene recovered by steam distillation. The remainder of this series of patents is devoted to a description of the various dyes which can be obtained from monoaminocymene by the following general reactions: (1) Diazotizing, followed by coupling with hydroxy or amino compounds; (2) Reduction with Zn in alkaline solution to form hydrocymene, which gives, by the benzidine reaction, dimethyl-di-isopropylbenzidine. This may be coupled with a variety of compounds. (3) Monoaminocymene and its derivatives may be mixed with aniline, nitrosophenol, aminophenols, etc., and fused with sulphur to form sulphur dyes. (1,314,920 to 1,314,929 inclusive; assigned to the Selden Co., of Pittsburgh; Sept. 2, 1919.)

Preparation of Pure Ethylene.—Ethylene may be separated from a gaseous mixture (formed, for example, by the process outlined in U.S.P. 1,315,540) by passing the gases through a neutral or acid solution of mercuric salts. In the case of mercuric sulphate, a compound having the empirical formula $HgSO_4.C_2H_4$ is formed at temperatures between 0 and 25 deg. C. The compound is decomposed on boiling the aqueous solution, yielding pure ethylene. (1,315,541; George O. Curme, Jr. of Pittsburgh, assignor, by mesne assignments, to Union Carbide Co.; Sept. 9, 1919.)

Acetone From Acetic Acid.—Acetone may be prepared from acetic acid in the vapor form by passing the same through tubes or vessels containing iron in a finely divided condition, as of fine shavings, maintaining these tubes or vessels at a temperature between 550 and 600 deg. C., at which temperature a quantitative yield of acetone is obtained from the acetic acid introduced, condensing the vapors issuing from this apparatus and then preparing from the condensate, by simple rectification, the pure acetone. (1,315,544; George O. Curme, Jr., of Pittsburgh, assignor, by mesne assignments, to Union Carbide Co.; Sept. 9, 1919.)

Ethylene and Propylene Dichlorides.—George O. Curme, Jr., of Pittsburgh claims that chlorination of ethylene and propylene proceeds with greater ease and rapidity in the liquid phase than in the gaseous phase. For example, pure chlorine was liquified in a vessel cooled to —78 deg. C. and gaseous propylene supplied through a tube reaching to the bottom of the vessel. The propylene liquefied before mixing with the chlorine. When the theoretical quantity of propylene had been added, the product was found to consist of 80 to 85 per cent propylene dichloride with 15 to 20 per cent higher chlorinated derivatives. (1,315,542, 1,315,545 and 1,315,547; assigned to Union Carbide Co.; Sept. 9, 1919.)

Personal

Mr. John H. Allison has joined the sales engineering department of the Celite Products Co., in the Pittsburgh district.

Dr. Sergio Bagnara is now consulting engineer and general manager of the Marine & Commerce Pocahontas Corp., Welch, W. Va.

Mr. H. A. Braendle, formerly of the general laboratories of the Canadian Consolidated Rubber Co., has joined the rubber section of the Ames Holden McCready System, as physicist in charge of its Montreal laboratories.

Mr. C. E. Carstens of Anaconda, Mont., has accepted a position with the Andes Copper Mining Co., at Potrerillos, Chile.

Mr. O. A. P. Clark of Murray Howe & Co., New York City, has resigned to accept a position as assistant operating chemical engineer with the Newport Co., of Milwaukee, Wis., at its Carrollville works.

Mr. William M. Corse has resigned as technical superintendent of the Ohio Brass Co. to accept a position as general manager of the Monel Metal Products Corp. of Bayonne, N. J.

Mr. Robert S. Davis has taken a position with Walker Bros. Consolidated Copper Co., at Portola, Calif.

Mr. Ross H. Dickson, formerly captain in the Ordnance Department, U. S. A., and engaged on the construction of toluol recovery plants during the war, before which he was with the Semet-Solvay Co., has just been released from the service and is now located with the Standard Oil Co. of New Jersey at the Bayway refinery, Elizabeth, N. J., as chemical engineer in the manufacturing development division.

Mr. Walter Dobbins, formerly with the Chino Copper Co. at Hurley, N. Mex., has gone to Chuquicamata, Chile, in the employ of the Chile Exploration Co.

Mr. D. K. French, who has served the Chicago section of the American Chemical Society as secretary and treasurer for nine years, on retiring from active participation in the work, was presented with a testimonial subscribed by the members as an appreciation of his long and faithful service.

Mr. Walter H. Garasha has severed his connection with the Deegan Supply Co., and associated himself with the Atlas Laboratory Equipment Bureau, Chicago, Ill.

Mr. Louis J. Gurevich has resigned his position as assistant physicist in metallurgy with the Bureau of Standards and has accepted the position of metallurgist in the research department of the Hydraulic Pressed Steel Co. at Cleveland, Ohio.

Mr. F. D. **Harger** has accepted the position of general manager and vice-president of the Mono Corporation of America, Buffalo, N. Y.

Mr. H. H. **Harris** has been appointed manager for the department of heat-treating equipment of the Quigley Furnace Specialties Co., New York. Mr. Harris was formerly general sales manager for the Swedish Crucible Steel Co.

Mr. W. W. **Hartman** has accepted employment with the Eastman Kodak Co. as research chemist on organic chemicals.

Mr. **Ellwood Hendrick**, consulting editor of **Chemical & Metallurgical Engineering**, delivered a lecture under the auspices of the Pittsburgh chapter of Phi Lambda Upsilon at Carnegie Lyceum Hall on the evening of Dec. 3 on "Chemistry for Every Man." At noon of the same day Mr. Hendrick addressed the student body of the University of Pittsburgh.

Mr. J. D. **Jones**, recently with the Illinois Steel Co., is now general superintendent of the Algoma Steel Corp., at Sault Ste. Marie, Canada.

Mr. **Louis J. Krom** has resigned as managing editor of *Metal Industry* to accept a position as works manager with the new rolling mill of the West Virginia Metal Products Corp. He will continue on the staff of *Metal Industry* as rolling mill editor. Mr. **Adolph Bregman** is the new managing editor.

Mr. H. F. **McConnell** has recently become superintendent in charge of the Louisville plant of the Tobacco By-products and Chemical Corporation.

Mr. L. H. **Nelson** has resigned his position as research chemist for the Goodrich Rubber Co. at Rock Island, Ill., and taken a position in the laboratory of the Standard Textile Products Co.

Mr. **James G. Parmelee**, recently research metallurgist with the School of Mines in co-operation with the U. S. Bureau of Mines, at Moscow, Idaho, is now connected with the Hardinge Conical Mill Co., Salt Lake City, Utah.

Mr. W. L. **Penick**, until recently connected with the Salt Lake City office of the Hardinge Conical Mill Co., has been advanced to the position of Northwest sales manager, and will open a new branch office in Spokane, Wash.

Commander **Donald Riley** of the U. S. Naval Reserves has received the Order of the Crown from King Albert of Belgium for his service in that country as chemistry expert.

Mr. H. F. **Schippel**, formerly research engineer of the Canadian Consolidated Rubber Co., has joined the rubber section of the Ames Holden McCready System, as research engineer.

Mr. **Frank H. Smith**, until recently general manager of the East Helena plant of the American Smelting & Refining Co. and associated with the company since its organization, has accepted the position of assistant of the Bunker Hill & Sullivan Mining & Concentrating Co., at Kellogg, Idaho.

Mr. R. T. **Walker** has resigned as superintendent of the Virginia Louise Mining Co. at Pioche, Nev., to become manager of the Ore Purchasing Department, United States Smelting, Refining & Mining Co., at Salt Lake City, Utah.

Dr. **Gerald** L. **Wendt**, of the University of Chicago, recently delivered a talk on "The Revelations of Radium," at the meeting of the Davenport Commercial Club.

Obituary

William Dixon Weaver, former editor of the *Electrical World*, died at his home in Charlottesville, Va., on Nov. 1, death coming apparently from heart failure while he slept. Mr. Weaver was born in Greensburg, Pa., Aug. 30, 1857, and after completing his studies at Kentucky University entered the United States Naval Academy, from which he was graduated in the class of 1880 as cadet engineer. The next twelve years were spent in the Navy. In 1893 Mr. Weaver was made editor of the *Electrical World*, then published by the W. J. Johnston Co. This journal was later purchased by Mr. McGraw and consolidated with the *American Electrician* and the *Electrical Engineer*. Mr. Weaver continued as editor until May, 1919. He was intensely interested in the organization of the electrical engineering profession and in the societies through which it was perfected. He served six years as manager of the American Institute of Electrical Engineers and was one of the founders of the Illuminating Engineering Society and the American Electrochemical Society.

Mr. E. C. **McKelvy**, chief of the Physical Chemistry Section of the Chemistry Division of the Bureau of Standards, died of burns Nov. 29. The accident which resulted in his death occurred on Friday, Nov. 28, and the burns he sustained were at first considered not grave. Mr. McKelvy was active as secretary of the Washington Chemical Society and was a member of the American Chemical Society, the Washington Academy of Sciences, the American Association for the Advancement of Science and several other technical and scientific organizations.

Current Market Reports

The Non-Ferrous Metal Market

New York, December 22, 1919—Lead and tin have advanced, but copper remains at 28½c. There has also been a general rise in the price of scrap metals.

	Cents per Lb.
Aluminum, 98 to 99 per cent	32.00–33.00
Antimony, wholesale lots	9.75
Nickel, ordinary	42.00
Nickel, electrolytic	45.00
Tin, Straits, spot	53.50
Lead, New York, spot	7.25
Lead, E. St. Louis, spot	7.00
Zinc, New York	8.57½
Zinc, E. St. Louis	8.22½
Silver (Cents per oz.)	1.34

FINISHED METAL PRODUCTS

	Warehouse Prices, Cents per Lb.
Copper sheets, hot rolled	28.50
Copper sheets, cold rolled (over 14 oz.)	30.50
Copper bottoms	37.00
Copper rods	29.50
High brass wire and sheets	25.50
High brass rods	24.50
Low brass wire and sheets	28.25
Low brass rods	28.25
Brazed brass tubing	37.25
Brazed bronze tubing	42.00
Seamless copper tubing	32.00
Seamless bronze tubing	36.00
Seamless brass tubing	30.50

SCRAP METALS

	Buying Prices
Aluminum castings	22.00–23.50
Aluminum sheets	21.00–22.50
Lead, heavy	5.60– 5.85
Lead, tea	4.38– 4.50
Zinc, scrap	4.50
Copper, heavy cut and crucible	15.50
Copper, heavy and wire	13.50
Copper, light and bottoms	12.50
Brass, heavy	8.00
Brass, light	6.15

The Iron and Steel Market

In the steel mills and departments that had been closed by coal shortage there has been a rapid resumption since the Indianapolis settlement of Wednesday, Dec. 10. The following Monday the majority of the closed departments opened, although it was only on that day that coal production on any large scale was beginning at the union mines. The quick resumption was due chiefly to the prompt release of coal which the railroads, under direction of the Fuel Administration, had been holding in reserve to be parceled out for the most essential uses. An estimate that seems fair is that of the total amount of consigned coal held by the railroads on Nov. 1, when the coal strike started, about one-third remained at the time of the Indianapolis settlement. Much of this coal lay near, but not in, the original consignee's works, and the release of the coal meant immediate delivery. The total curtailment in steel production due to coal shortage was an important item on the basis of a week's production, but a small item in comparison with a month's normal output, and an insignificant amount in a year's total.

Blast-Furnaces Decrease Production

The blast-furnaces have not been having as easy a time as the steel mills. The by-product coke ovens have been increasing their operations but are not yet running full and may not until after Christmas. As to the Connellsville region, its production of coke was to be restricted by 25 per cent according to the original order, but by 50 per cent according to the final order, this order being rescinded Saturday morning, Dec. 13. In the week ending on that day the actual coke production in the Connellsville and Lower Connellsville region, according to the report of the Connellsville *Courier*, was 191,600 tons, a decrease of 71,210 tons, or 27 per cent, from the output of the preceding week, when the output was larger than the November average, which was to be taken in figuring the decrease. This was a good showing from the blast-furnace standpoint, but in the week following the production has not materially increased and may indeed prove to have been a trifle less. The difficulty was in car supply. The week opened with 100 per cent car supply on Monday, this decreasing to 70 per cent the next day and to 40 per cent the day following, while for Saturday few if any cars were expected. The railroads do not seem to have been affected as much as in previous years by the first real cold snap of the season, but they were very busy with coal movement. The Monongahela Railroad in particular was practically congested with loaded coal. The blast-furnaces may not be in easy position in the matter of coke until the early part of January, particularly as the holidays always produce troubles of their own in the matter of coke production. Few furnaces have banked or will have to bank, but quite a number have slowed down. Moderately large stocks had been accumulated by many furnaces before the pinch came.

Pig Iron Advance Continues

The Philadelphia and Buffalo pig iron markets have gone up $1 a ton, and so has the Southern market. Prices at valley furnaces are up $1 on bessemer and $2 on basic, while foundry iron has now brought for second quarter the same price previously ruling for prompt and early deliveries only. The market on foundry iron now stands as follows: Philadelphia, $41.10; Buffalo, $40; Cleveland, $38.40; Chicago, $40; Birmingham, $35. The valley market stands at $36 for bessemer, $35 for basic and $38 for foundry, irrespective of delivery.

The pig iron markets have been showing signs of quieting down and precedents will be broken if the next fortnight, on account of the holidays, is not decidedly quiet. While some merchant furnacemen predict a continuation of the advance next year, it has been noted in past years that the market does not automatically resume, after a holiday dullness, where it left off, but requires a fresh impetus. With consumers apparently fairly well covered for the next few months, this impetus may not be furnished.

Steel Scarcity Spreads

Measured by the descriptions of steel for which premiums, or advances over the March 21 price schedule, can be secured, the steel scarcity has spread, since plates are now on the list. A month ago plates could be had on attractive orders at 2.50c., against the 2.65c. price in the March 21 schedule, but in the past few days lots of 1000 tons and over have gone at 2.75c. for delivery over a few weeks. The Steel Corporation's price, of course, remains at 2.65c., and indeed the corporation has made various tenders in the past few months to the Navy Department at 2.50c.

The wire nail situation is not relieved, the wire mills having particular difficulty in getting output from their nail departments. Some descriptions of spring wire are very scarce. Hot and cold rolled strip continue extremely scarce.

Throughout the steel industry much difficulty is experienced in getting tonnage results. There is both a shortage of men and a low level of morale and efficiency. The iron and steel strike is over, so far as there being any number of men still on strike, but some men have drifted into other employments. Even the Wheeling district, the last to hold out, is done with the strike. The two pipe mills in the district are already in partial operation, also the La Belle and Laughlin tin plate plants. The Yorkville plant has been operating for several weeks.

The Ferro-Alloy Market

The market during the past week has been flat, displaying nothing of particular interest in prices, demand or supply.

Ferrochrome, 6-8 per cent carbon contained, dropped from 23-24c. per lb. to 19-20c. per lb., while 4-6 carbon contained lowered to 21c. per lb., against 25c. of the previous week. There has been a brisk market on *molybdenite*, 85 per cent MoS_2, which is being quoted nominally at 75-85c. per lb., with very little available.

There is a moderately good demand for *ferromanganese*, and domestic makers have made several sales at their recently advanced price of $120, delivered. Reports are that offerings of English ferromanganese have appeared again, sales being made at $110, c.i.f., but with no quotations out now at that figure. *Spiegeleisen* is $38 to $40, f.o.b. furnace.

Electrolytic ferrosilicon has advanced lately and is now held at $90 for 50 per cent and at $140 to $150 for 75 per cent, delivered Pittsburgh, Cleveland, etc. Bessemer ferrosilicon is quoted as follows: 10 per cent, $59.50; 11 per cent $62.80; 12 per cent, $66.10, f.o.b. Jackson, Ohio.

The Chemical Market

New York, December 19, 1919.

The market of the past week compared with the previous report is easier; prices have remained firm but demand has fallen off slightly, which is partly due to the fact that inventories are being taken.

Sodium bichromate, which has been soaring lately and has been quoted as high as 45c. per lb., has had a turn, and with the present stock on hand the price has dropped to 19-25c. per lb. The low end of the *formaldehyde* quotation has dropped to 20c., which makes the present listing 20-37c. per lb., while *caustic soda* is scarce and has jumped from $3.80 per cwt. to $4.30. The hoarding of silver in India and China is one of the causes of the scarcity of that metal which in turn placed *silver nitrate* on a very unstable footing. The quotation at the present writing is 81⅝-82⅝c. per oz., but with the present fluctuation this price will probably change within the hour. There is no *denatured alcohol* available and the price has jumped from 72-78c. to 80c. per gal. on 188 proof and from 68 to 76c. per gal. on 190 proof.

The future of the *coal-tar* industry is especially bright and increased activity is expected in both foreign and domestic markets. Foreign inquiries have not been so heavy during the past week. *Dimethylaniline* is still in large demand and has come up to a high mark of 92c. per lb., as contrasted with 85c., the corresponding figure of last week. The present quotation on this item is from 60 to 92c. per lb. *Aniline salts* at present are active at 40-42c. per lb., against 37c. of last week, while *aniline oil* also advanced from 34-35c. per lb. to 35-36c. Very little *phenol* remains on the market, most of the output being already sold. A nominal quotation of 12¾-16c. per lb. still remains.

The *waxes* continue firm, with especial activity in the paraffine grades. Demand is still a step ahead of supply in these lines, but there has been no material change in prices. In the *flotation oils* demand is rather brisk, with the Government price of $1.25 per gal. still in effect on the pine oil steam dist. sp.gr. 0.930-0.940 and $1 on the pure dist.

There has been a slight falling off of foreign inquiry in *naval stores*, but prices remain the same. The low prices mentioned last week are holding in the Southern market, which tends to stabilize New York quotations.

In the *crude rubber* market up river fine dropped to 47½-48c. per lb., against 53-54c. per lb. of last week, while first latex went up to 52c. compared with 51½c. of the previous report. There has been very little activity in this line, rubber buyers seeming to have ample stocks.

Linseed oil has been under considerable inquiry and there has been a slight advance in price, raw car lots being quoted at $1.90 against $1.87 per gal. last week, and raw tank cars at $1.85 per gal., compared with $1.83 a week ago.

The Government prices of *coke* remain unaltered, foundry being listed at $6 and furnace at $7 per ton; the output of furnace coke has been greatly increased to meet the large demand.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	......-......	$0.60 -$0.65
Acetone	lb.	$0.20 -......	.21 -......
Acid, acetic, 28 per cent	cwt.	2.50 -$2.75	3.00 - 3.25
Acetic, 56 per cent	cwt.	5.00 - 5.50	6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	13.00 -13.50	13.50-15.50
Boric, crystals	lb.	.15 - .15½	.15½- .16½
Boric, powder	lb.	.14½- .15	.15 - .16
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	.... -	2.25 - 2.50
Hydrofluoric, 52 deg.	lb.	.12 -......	.14 -......
Lactic, 44 per cent. tech	lb.	.11 - .14	.12 - .16
Lactic, 22 per cent. tech	lb.	.05 - .06	.05½- .07
Molybdic, C. P	lb.	......-......	4.00 - 4.25
Nitric, 40 deg.	lb.	.06 - .06½	.07 - .08½
Nitric, 42 deg.	lb.	.07 - .07½	.08 -......
Oxalic, crystals	lb.	.30 - .31	.30 - .33
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 -......	.10 - .14
Picric	lb.	.30 - .35	.40 - .50
Pyrogallic, resublimed	lb.	......-......	2.30 - 2.60
Sulphuric, 60 deg., tank cars	ton	12.00 - 16.00	......-......
Sulphuric, 60 deg., drums	ton	17.00 -......	22.00 -......
Sulphuric, 60 deg., carboys	ton	20.00 -......	25.00 -......
Sulphuric, 66 deg., tank cars	ton	17.00 -18.00	22.00 -23.00
Sulphuric, 66 deg., drums	ton	20.00 -21.00	25.00 -26.00
Sulphuric, 66 deg., carboys	ton	25.00 -......	30.00 -40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 -......	26.00 -......
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 -......	32.00 -......
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 -......	35.00 -......
Tannic, U. S. P	lb.	......-......	1.35 - 1.45
Tannic (tech.)	lb.	......-......	.42 - .55
Tartaric, crystals	lb.	......-......	.69 - .74
Tungstic, per lb. of WO	lb.	......-......	1.20 - 1.40
*Alcohol, Ethyl	gal.	4.80 - 4.95	5.50 -......
*Alcohol, Methyl	gal.	1.30 -......	1.33 - 1.38
*Alcohol, denatured, 188 proof	gal.	...... -......	.80 - .82
*Alcohol, denatured, 190 proof	gal.	...... -......	.76 - .78
Alum, ammonia lump	lb.	.03½- .04½	.04½- .04¾
Alum, potash lump	lb.	.08 - .08¾	.09 - .09½
Alum, chrome lump	lb.	.15 - .16	.18 - .20
Aluminum sulphate, commercial	lb.	.01¾- .02	.02¼- .02½
Aluminum sulphate, iron free	lb.	.02¾- .03	.03¼- .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½-......	.09½- .10
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	......-......	.30 - .33
Ammonium carbonate, powder	lb.	.13 - .13½	.14 - .14½
Ammonium chloride, granular (white salammoniac)	lb.	.13¾- .14	.14½- .15½
Ammonium chloride, granular (gray salammoniac)	lb.	.12 - .12½	.13 - .13½
Ammonium nitrate	lb.	.10 -......	.11 - .12
Ammonium sulphate	lb.	.05 -......	.06 -......
Amyl acetate	gal.	......-......	3.65 - 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	......-......	.09 - .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	......-......	......-......
Barium chloride	ton	90.00 - 95.00	95.00 -100.00
Barium dioxide (peroxide)	lb.	.22 -......	.24 -......
Barium nitrate	lb.	.09½- .10½	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.03 - .03½	.03½- .04
Bleaching powder (see calcium hypochlorite)		......-......	......-......
Blue Vitriol (see copper sulphate)		......-......	......-......
Borax (see sodium borate)		......-......	......-......
Brimstone (see sulphur, roll)		......-......	......-......
Bromine	lb.	......-......	.65 - .75
Calcium acetate	cwt.	2.00 - 2.05	2.10 -......
Calcium carbide	lb.	......-......	.04½- .05
Calcium chloride, fused, lump	ton	19.00 -25.00	30.00 -40.00
Calcium chloride, granulated	lb.	.01½- .01¾	.02 - .02½
Calcium hypochlorite (bleaching powder)	cwt.	......-......	2.75 - 3.75
Calcium peroxide	lb.	......-......	1.50 - 1.70
Calcium phosphate, monobasic	lb.	......-......	.02 - .03
Calcium sulphate, precipitated	lb.	......-......	.09 - .09½
Carbon bisulphide	lb.	.05½-	.06 - ....
Carbon tetrachloride, drums	lb.	.10 - .11	.12 - .14
Carbonyl chloride (phosgene)	lb.	......-......	.75 -......
Caustic potash (see potassium hydroxide)		......-......	......-......
Caustic soda (see sodium hydroxide)		......-......	......-......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 - .05½	.08 -......
Cobalt oxide	lb.	......-......	1.50 - 1.55
Copperas (see iron sulphate)		......-......	......-......
Copper carbonate, green precipitate	lb.	......-......	.28 - .31
Copper cyanide	lb.	......-......	.65 - .70
Copper sulphate, crystals	lb.	.08½- .08¾	.09 - .09½
Cream of tartar (see potassium bitartrate)		......-......	......-......
Epsom salt (see magnesium sulphate)		......-......	......-......
Formaldehyde, 40 per cent	lb.	......-......	.20 - .37
Glauber's salt (see sodium sulphate)		......-......	......-......
Glycerine	lb.	......-......	.24½- .26
Iodine, resublimed	lb.	......-......	4.50 -......
Iron oxide, red	lb.	......-......	.03 - .20
Iron sulphate, (copperas)	cwt.	1.00 -......	1.20 - 1.50
Lead acetate, normal	lb.	......-......	.15 - .16
Lead arsenate (paste)	lb.	......-......	.13 - .17
Lead nitrate, crystals	lb.	......-......	.85 - .86½
Litharge	lb.	......-......	.09½- .10½
Lithium Carbonate	lb.	......-......	.50 -......
Magnesium carbonate, technical	lb.	......-......	13 - .14½
Magnesium sulphate, U. S. P	100 lb.	2.00 - 2.63	2.75 - 3.00
Magnesium sulphate, commercial	100 lb.	1.75 -......	2.00 - 2.50
Nickelsalt, double	lb.	.14 -......	.15 -......
Nickel salt, single	lb.	.12 -......	.15 - .16
Phosgene (see carbonyl chloride)		......-......	......-......
Phosphorus, red	lb.	......-......	.75 - .90
Phosphorus, yellow	lb.	......-......	.35 - .37
Potassium bichromate	lb.	.26 - .27	.30 - .35
Potassium bitartrate (cream of Tartar)	lb.	......-......	.58 - .60
Potassium bromide, granular	lb.	......-......	.50 - .65
Potassium carbonate, U. S. P	lb.	.60 -......	.65 - .70
Potassium carbonate, crude	lb.	.29 -......	.30 -......
Potassium chlorate, crystals	lb.	.30 - .20	.21 - ...
Potassium cyanide, 98-99 per cent	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.28 - .32	.35 - .40
Potassium iodide	lb.	......-......	3.55 - 3.60
Potassium nitrate	lb.	.19 -......	.21 -......
Potassium permanganate	lb.	......-......	.55 - .65
Potassium prussiate, red	lb.	......-......	1.05 - 1.15

*Nominal quotations.

		Carlots	Less Carlots
Potassium prussiate, yellow	lb.	...... -......	$0.36 -$0.40
Potassium sulphate	ton	225.00 -......	......-......
Rochelle salts (see sodium potas. tartrate)		......-......	......-......
Salammoniac (see ammonium chloride)		......-......	......-......
Sal soda (see sodium carbonate)		......-......	......-......
Salt cake (sodium sulphate)	ton	17.00 -21.00	......-......
Silver cyanide	oz.	......-	1.25 -......
Silver nitrate	oz.	......-	.81½- 82½
Soda ash, light	100 lb.	2.00 -......	2.05- ....
Soda ash, dense	100 lb.	2.25 - 2.35	2.50 - 2.75
Sodium acetate	lb.	.05½- .06½	.07 - .08
Sodium bicarbonate	100 lb.	2.60 -......	2.75 - 3.00
Sodium bichromate	lb.	......-......	.19 - .25
Sodium bisulphate (nitre cake)	ton	3.00 - 8.00	10.00 -......
Sodium bisulphite	cwt.	1.80 - 1.90	2.00 - 2.10
Sodium borate (borax)	lb.	.08 - .09	.09 - .10
Sodium carbonate (sal soda)	100 lb.	1.35 - 1.50	1.50 - 1.75
Sodium chlorate	lb.	.15 -......	.16 - .18½
Sodium cyanide, 96-98 per cent	lb.	.30 -......	.31 - .34
Sodium fluoride	lb.	.14 -......	.15 - .16
Sodium hydroxide (caustic soda)	100 lb.	......-......	..... - 3.80
Sodium molybdate	lb.	2.50 -......	3.25 -......
Sodium nitrate	100 lb.	......- 3.25	3.75 - 4.00
Sodium nitrite	lb.	.15 - .17	... - .18
Sodium peroxide, powdered	lb.	......-......	.30 - .32
Sodium phosphate, dibasic	lb.	.03½- .04	.04½- .05
Sodium potassium tartrate (Rochelle salts)	lb.	......-......	.43 - .45½
Sodium prussiate, yellow	lb.	.23 - .24	.24 - .25
Sodium silicate, solution (40 deg.)	lb.	.01¾- .02	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	.02¾- .03	.03½- .04¾
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.15 - 1.25	1.50 - 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	......-......	.05 - .06
Sodium sulphite, crystals	lb.	.03½-......	.04 - .06
Strontium nitrate, crystals	lb.	.25 -......	.28 -......
Sulphur chloride	lb.	.05½-......	.06 -......
Sulphur, crude	ton	22.00 -......	......-......
Sulphur dioxide, liquid, cylinders	lb.	......-......	.10 - .12
Sulphur (sublimed), flour	100 lb.	3.10 -......	3.40 - 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 -......	3.15 - 3.40
Tin bichloride (stannous)	lb.	.44 -......	.46 - .50
Tin oxide	lb.	......-......	.60 -......
Zinc carbonate, precipitate	lb.	......-......	.20 -......
Zinc chloride, fused	lb.	.12½-......	.13½- .14
Zinc cyanide	lb.	.49 -......	.50 -......
Zinc dust	lb.	.09 - .11	.11 - .14
Zinc oxide, dry American	lb.	......-......	.09½- .12
Zinc sulphate	lb.	.03½- .03¾	.04 - .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.32	—	.50
Aniline oil, drums extra	lb.	.35	—	.36
Aniline salts	lb.	.40	—	.42
Anthracine, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.00	—	1.15
Benzidine, base	lb.	1.10	—	.....
Benzidine, sulphate	lb.	.90	—	1.00
Benzoic acid, U. S. P	lb.	.90	—	1.10
Benzoate of soda, U. S. P	lb.	.80	—	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27	—	31
Benzol, 90%, in drums (100 lb.)	gal.	.25	—	.29
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	.50	—	.52
Beta naphthol, sublimed	lb.	.75	—	.80
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2 25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.80	—	.85
Cresylic acid, 95-97%, dark, in drums	gal.	.85	—	.90
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.40	—	2.25
Dimethylaniline	lb.	.60	—	.92
Dinitrobenzol	lb.	.26	—	.37
Dinitroclorbenzol	lb.	.25	—	.30
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.32	—	.36
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.65
Diphenylamine	lb.	.58	—	.75
H-acid	lb.	1.60	—	1.75
Metaphenylenediamine	lb.	1.15	—	1.80
Monochlorbenzol	lb.	.12	—	.15
M onoethylaniline	lb.	1.50	—	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.06½	—	.07½
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	.75	—	1.25
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.40	—	.45
Nitro-toluol	lb.	.27	—	.20
Ortho-amidophenol	lb.	3.00	—	4.25
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.90	—	1.25
Ortho-nitro-toluol	lb.	.25	—	.40
Ortho-toluidine	lb.	.25	—	.45
Para-amidophenol, base	lb.	2.50	—	3.50
Para-amidophenol, HCl	lb.	2.50	—	3.25
Para-dichlor-benzol	lb.	.15	—	.18
Paranitraniline	lb.	1.15	—	1.25
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.50	—	4.00
Paratoluidine	lb.	2.00	—	2.50
Phthalic anhydride	lb.	1.50	—	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12½	—	.16
Pyridin	gal.	2.00	—	2.50
Resorcin, technical	lb.	3.75	—	4.00
Resorcin, pure	lb.	6.50	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45	—	.60
Salicylic acid, U. S. P	lb.	.45	—	.50
Salol	lb.	.90	—	.95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.22	—	.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30

Tolidine	lb.	$1.70	—	$2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	28	—	.....
Toluol, in drums	gal.	.32	—	.30
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.42	—	$0 44
Beeswax, refined, yellow	lb.	47	—	.48
Beeswax, white pure	lb.	.63	—	.66
Carnauba, No. 1	lb.	.80	—	.83
Carnauba, No. 2, regular	lb.	.65	—	.78
Carnauba, No. 3, North Country	lb.	.44	—	.50
Japan	lb.	.18½	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	.07
Paraffine waxes, crude, scale 124-126 m.p.	lb.	....	—	.06½
Paraffine waxes, refined, 118-120 m.p.	lb.	....	—	.09
Paraffine waxes, refined, 128-130 m.p.	lb	.09¾	—	.10½
Paraffine waxes, refined, 133-135 m.p.	lb.	....	—	.12
Paraffine waxes, refined, 135-137 m.p.	lb.	....	—	.13
Stearic acid, single pressed	lb.	.23	—	.26
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.25
Pine oil, pure, dest. dist.	gal.	1.00
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.47
Pine tar oil, crude, sp.gr.1.025-1.035 tank cars f.o.b.Jacksonville,Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.00
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	....
Pinewood creosote, ref.	gal.	.51

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$17.00	—	$17.50
Rosin E-I	280 lb.	17.55	—	18.25
Rosin K-N	280 lb.	19.75	—	23.00
Rosin W. G.-W. W	280 lb.	22.50	—	24.25
Wood rosin, bbl	280 lb.	17.00	—	17.50
Spirits of turpentine	gal.	1.65	—	1.66
Wood turpentine, steam dist	gal.	1.63	—	....
Wood turpentine, dest. dist	gal.	1.50	—	....
Pine tar pitch, bbl	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	14.90
Retort tar, bbl	280 lb.	15.00	—	15.25
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.95	—	1.12
Rosin oil, fourth run	gal.	1.05	—	1.15

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.53	—	$0.54
Upriver coarse	lb.	....	—	.35½
Upriver caucho ball	lb.	.34½	—	.35½
Plantation—First latex crepe	lb.	.51½	—	....
Ribbed smoked sheets	lb	.51½	—	....
Brown crepe, thin, clean	lb.	.46½	—	.47½
Amber crepe No. 1	lb.	.49	—	....

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.18½	—	$0.19
Castor oil, AA, in bbls	lb.	.21½	—	.22
China wood oil, in bbls	lb.	.22½	—	.23
Cocoanut oil, Ceylon grade, in bbls	lb.	.17½	—	.18½
Cocoanut oil, Cochin grade, in bbls	lb.	.19½	—	.20
Corn oil, crude, in bbls	lb.	....	—	.21½
Cottonseed oil, crude (f.o.b. mill)	lb.	.18	—	.19
Cottonseed oil, summer yellow	lb.	....	—	.27
Cottonseed oil, winter yellow	lb.	....	—	.28
Linseed oil, raw, car lots	gal.	....	—	1.87
Linseed oil, raw, tank cars	gal.	....	—	1.83
Linseed oil, boiled, car lots	gal.	....	—	1.90
Olive oil, commercial	gal.	2.50	—	2.80
Palm, Lagos	lb.	.17	—	.17½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.23½	—	.23½
Peanut oil, refined, in bbls	lb.	.27	—	.28
Rapeseed oil, refined in bbls	gal.	1.45	—	1.50
Rapeseed oil, blown, in bbls	gal.	1.60	—	....
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.17½	—	.18½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½	—	.15½

FISH

Winter pressed Menhaden	gal.	$1.20	—	.....
Yellow bleached Menhaden	gal.	1.23	—	....
White bleached Menhaden	gal.	1.25	—	.....
Blown Menhaden	gal.	1.26	—	....

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	30.00	—	50.00
Casein	lb	16	—	.18
Chalk, English, light	lb.	.05	—	.07
Chalk, English, light	lb	04½	—	.06
Chalk, English, dense	lb.	$ .04	—	$ .05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	13.50	—	17.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	30.00	—	35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	1.10	—	1.15
Shellac, D. C.	lb.	.....	—	....
Shellac, V. S. O.	lb.	.....	—	....
Shellac, Diamond I.	lb.	.....	—	....
Shellac, orange, fine	lb.	1.25	—	.....
Shellac, orange, superfine	lb.	1.20	—	1.30
Shellac, A.C. garnet	lb.	1.10	—	.....
Shellac, bleached, bone dry	lb.	1.35	—	.....
Shellac, bleached, fresh ground	lb.	1.10	—	1.15
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	1,000	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o,b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.40
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon	lb.	0.21	—	.50
Ferro-manganese, 70-80% Mn	gross ton	110.00	—	115.00
Spiegeleisen, 16-20% Mn	gross ton	33.00	—	41.00
Ferro-molydenum, per lb. of Mo	lb.	3.00	—	3.50
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, $C_2.O_3$	unit	$0.60	—	$0.80
Chrome ore, 48% and over	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	—	7.50
*Coke, furnace, f.o.b. ovens	net ton	6.00	—	6.50
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines	net ton	.....	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

* Government prices.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.80
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	16.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	50.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	40.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	1.75
Linseed oil, 5 gal. cans	gal.	1.90
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

NOTE—These items were compiled as of Dec. 22, but appear in this issue due to the delay in publication due to the printers' strike.

California

LOS ANGELES—The Los Angeles Soap Co., 638 East 1st St., is having plans prepared for the construction of a 30 x 40 x 80 ft. distillery building, etc., in connection with its soap factory at 1st and Alameda Sts. Morgan, Walls & Morgan, 1124 Van Nuys Bldg., architects.

Connecticut

WATERBURY—The Scoville Manufacturing Co., 99 Mill St., will build a 1-story, 80 x 100-ft. paint shop and 1-story, 12 x 22-ft. addition to its sub-station on Silver St. Estimated cost, $28,000. Work will be done by day labor.

Illinois

JACKSONVILLE—The city clerk will receive bids in January for the construction of a 1,500,000-gal. capacity filtration plant. Estimated cost, $50,000. S. A. Greeley, 39 West Adams St., Chicago, engineer.

Louisiana

MONROE—The city voted $1,450,000 bonds, part of which will be used for improvements to the waterworks, including a 3,000,000-gal. capacity filtration plant.

Massachusetts

WESTFIELD—The Vitrified Wheel Co., Emery St., will soon award the contract for the construction of a 2-story, 42 x 85-ft. manufacturing plant. Estimated cost, $25,000.

Michigan

DETROIT—The Detroit Motor Castings Co., Beaufait St., has awarded the contract for the construction of a 1-story, 60 x 155-ft. brass foundry, to J. L. Hopkins, Sun Bldg. Estimated cost, $35,000. Noted Oct. 22.

LANSING—The Allyne-Ryan Foundry Co., Aetna Rd., Cleveland, has awarded the contract for the construction of a 1-story, 300 x 400-ft. gray iron foundry, to the Christman Construction Co., 302 Union Trust Bldg., South Bend, Ind. Estimated cost, $300,000.

Minnesota

COLERAINE—A. King, secretary of the Board of Education, will receive bids in March for the construction of a 2-story, 150 x 270-ft. high school in the Canistes District. A special laboratory and a science department will be installed in same. Estimated cost, $500,000. W. T. Bray, Torrey Bldg., Duluth, architect and engineer.

Montana

HARDIN—The city has awarded the contract for the construction of a water filtration plant, including a 2-story, 39 x 56-ft. building, a 30 x 44-ft. filter building with a capacity of 1,000,000 gal. per day, and a 32 x 56-ft. coagulating basin, to the Security Bridge Co., 502 West 32nd St., Billings. Estimated cost, $89,517.

New Jersey

NEW BRUNSWICK—The city plans to issue $13,000 bonds for the construction of additional units at the filtration plant.

New York

COLLEGE POINT—The American Hard Rubber Co. is having plans prepared for the construction of a 1-story, 120 x 130-ft. factory addition. Walter Kidde, 140 Cedar St., New York City, architect and engineer.

LONG ISLAND CITY—The G. M. Film Printing Co., Times Sq., New York City, has awarded the contract for the construction of a 2-story, 35 x 155-ft. film laboratory at Pierce and 8th Sts., to the Fleischman Construction Co., 531 7th Ave., New York City.

ROCHESTER—The city will build a large garbage and sewage disposal plant. Modern equipment will be installed in same.

ROCHESTER—The Josiah Anstice Co., Inc., plans to construct a 1-story, 145 x 216-ft. foundry building on Humboldt St. Estimated cost, $85,000.

SYRACUSE—The Mills Oil Co., 263 Walton St., plans to build 4 or 5 buildings, including an oil and gasoline building, on North Clinton St. Estimated cost, $200,000.

UTICA—Peter E. Hoffman, 2234 Whitesboro St., plans to construct a 1-story, 50 x 500-ft. factory building on Sunset Ave Molding machines, equipped with individual motors to manufacture 5000 concrete building blocks daily, will be installed in same. Estimated cost between $40,000 and $45 000.

WATERTOWN—The Board of Water, Light & Power has engaged Hazen, Whipple & Fuller, architects, 30 East 42nd St., New York City, to prepare plans for a settling basin to be added to the present water filtration system. Estimated cost, between $60,000 and $80,000.

North Dakota

DUNSEITH—The Board of Control is having plans prepared for the installation of a water-softening plant in the State Tuberculosis Sanitarium here. Estimated cost, $5000.

MAYVILLE—The city plans an election soon to vote on $10,000 bond for the installation of a water-softening plant. A. Joudet, city engineer.

Ohio

CANTON—The Weber Dental Manufacturing Co., 400 Cherry Ave., plans to construct a factory addition. One part will be used as an addition to the brass and aluminum foundry and another to the plating and polishing department. Estimated cost, $50,000.

CHILLICOTHE—The Mead Paper & Pulp Co., is having plans prepared for the construction of two buildings; 152 paper machines will be installed in same. Estimated cost, $60,000.

CLEVELAND—The Aetna Steel Castings Co. has awarded the contract for the construction of a 1-story, 20 x 35-ft. addition to its foundry at 2284 Scranton Rd., to W. I. Thompson, 5103 Euclid Ave. Estimated cost, $5000.

CLEVELAND—The city will soon award the contract for the construction of twelve 8 x 50-ft. grit chambers, flow channels, etc., in connection with the Easterly Sewage Treatment Works, foot of East 140th St. G. Gascoigne, 618 City Hall, engineer.

CLEVELAND—The Parish-Pool Copper Co., care of Paul E. Cleveland, Guardian Bldg., has awarded the contract for the construction of a 1-story, 150 x 500-ft. smelting and refining building on Clinton Rd., to A. W. Kilbourne Co., 6532 Euclid Ave. Estimated cost, $300,000.

COLUMBUS—The Columbus Dental Co., 634 Wagner St., engaged Otto Darst, architect, Brunson Bldg., to prepare plans and submit estimates for the construction of a 2-story, 38 x 100-ft. addition to its factory and a 2-story, 35 x 60-ft. office building. Estimated cost, $40,000.

DAYTON—The Miami Brass Foundry Co., McDonough and Bacon Sts., plans to build a 3-story, 75 x 120-ft. factory on McDonough St. Estimated cost, $100,000.

Pennsylvania

WILKES-BARRE—The Wyoming Valley Homeopathic Hospital, Dana St., plans to build a 4-story, 40 x 50-ft. hospital and will be in the market for laboratory equipment. Estimated cost, $90,000.

Tennessee

MEMPHIS—The Sugar Products Co., 16 Exchange Pl., New York City, plans to construct a molasses storage building to house a 500,000-gal. tank, etc. Estimated cost, $50,000.

Texas

BRECKENRIDGE—The Texas Co., 17 Battery Pl., New York City, has awarded the contract for the construction of a compressor and absorption plant, to Westinghuse, Church, Kerr, Inc., 37 Wall St., New York City. Estimated cost, $150,000.

CORSICANA—The Corsicana Oil & Refining Co. plans to build an oil refinery here. Estimated cost, $300,000. W. M. Elliott, 1004 West 3rd Ave., engineer.

WEST DALLAS (Dallas P. O.)—The Monarch Petroleum Co. has purchased a 30-acre site here and plans to construct a 5000-bbl. refinery on same. Estimated cost, $500,000. J. R. Aiken, Western Indemnity Bldg., Dallas, president.

Wisconsin

FORT ATKINSON — The Creamery Package Manufacturing Co., Fort Atkinson Bldg., has awarded the contract for the construction of a 2-story, 40 x 90-ft. enameling plant, to the Raulf Co., Patton Bldg., Milwaukee. Estimated cost, $25,000.

KEWASKUM—The Kewaskum Aluminum Co. has awarded the contract for the construction of a 2-story, 50 x 180-ft. factory, to John L. Stanage, 144 Oneida St., Milwaukee. Noted Oct. 29 and Nov. 5.

MANITOWOC—The Aluminum Goods Manufacturing Co., 15th and Franklin Sts., has awarded the contract for the construction of a 1-story, 300 x 340-ft. rolling mill, to W. W. Oeflein, 86 Michigan St., Milwaukee. Estimated cost, $300,000.

MILWAUKEE—The Pfister-Vogel Leather Co., 443 Virginia St., has awarded the contract for the construction of a 1-story, 150 x 300-ft. tannery at 2nd Ave. and Virginia St., to the Dahlman Construction Co., Majestic Bldg. Estimated cost, $125,000.

WEST ALLIS—Arthur Schneider, State Sanitary Engineer, City Hall, has recommended the reconstruction of the west end sewage disposal plant. Estimated cost, $10,000.

WEST BEND—The West Bend Aluminum Co. has awarded the contract for the construction of a 4-story, 72 x 144 x 192-ft. L shaped factory, also a 1-story, 72 x 120-ft. building, to the Northern Construction Co., Colby-Abbot Bldg., Milwaukee. Estimated cost, $100,000. Noted Oct. 29 and Nov. 5.

Ontario

FERGUS—J. Alpaugh & Son have purchased a site and are preparing plans for the construction of a modern marble works on same. Estimated cost, $25,000.

TORONTO—Appleon & Chimpman, consulting engineers, 68 Wellington St., E., are in the market for filter presses, feed dryers, etc.

Quebec

MONTREAL—B. J. Coghlin and Co., Ltd., 2050 Ontario St., will soon award the contract for the construction of a 2-story, 40 x 108-ft. factory for the manufacture of oils and greases, on Ontario St. Estimated cost, $18,600.

MONTREAL—The Canada Sugar Refining Co., 300 Montmorency St., has awarded the contract for the construction of a 3-story, 20 x 53-ft. sugar factory on Montmorency St., to the Church-Ross Co., Ltd., 10 Cathcart St. Estimated cost, $17,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a meeting in St. Louis from Dec. 26 to Jan. 1.

THE AMERICAN CERAMIC SOCIETY will hold its annual meeting in Philadelphia, Pa., Feb. 23-26.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive, in St. Louis.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9, and 10.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York, Feb. 16-19.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting in St. Louis from Dec. 26 to Jan. 1.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15.

THE MINING AND METALLURGICAL SOCIETY OF AMERICA will hold a meeting in New York Jan. 13.

Published December 31st, With Current News

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
WALLACE SAVAGE
Assistant Editor

ALAN G. WIKOFF
Assistant Editor
L. W. CHAPMAN
Western Editor
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 21 New York, December 24–31, 1919 *Number* 15

Optimists in Spite of Appearances

IT WOULD not be difficult even for an optimist to indulge in lugubrious feelings by retrospect on the year that is ending. Hailed with delight because hostilities in Europe had ceased and peace was in prospect, Nineteen Hundred and Nineteen has been a distinct disappointment in many respects, and few, probably, will mark its passing with regret. Industrial strikes during the year were numbered literally by the hundred, and the man who has not suffered inconvenience more or less acute by reason thereof must indeed be an individual of small consequence or one having slight contact with the world of affairs. In fact, turmoil and unrest have been so marked and have so directly affected the daily life of the people that cynical commentators have been led to contrast the serene period of the war with the stormy aftermath of the Armistice.

Consideration of the Treaty, abortive in its results due to the rôle played by partisan politics, has prevented Congress from giving needful attention to legislation on water-power development and tariff regulation on such commodities as dyes, potash, optical and chemical glass, porcelain and certain metals and minerals. All data essential to the information of Congress on these subjects have long since been presented by the Tariff Commission and representatives of the industries, and committee reports have been prepared as a result of extended hearings.

But if the year's events afford occasion for dissatisfaction, we still believe that

> Sweet are the uses of adversity,
> Which, like the toad, ugly and venomous,
> Wears yet a precious jewel in its head.

If our own experience with arbitrary and unreasonable strikes, called and directed by irresponsible leaders, points a moral, and if the reaction of our subscribers and advertisers can be taken as typical of public sentiment toward such actions, we are constrained to believe that the strike has lost much of its force as a weapon of offense for Labor. If this be true, we will indeed have discovered a "precious jewel" which Labor itself may yet come to admire. And this is said in all sincerity and with cordial interest in the just deserts of Labor, for it has always seemed to us incongruous in the extreme that the most effective weapon thus far developed by Labor—the strike—should react against its intended beneficiaries, often with fatal force. We are confident that the future will develop new and more effective, as well as peaceful, means for preserving industrial peace and averting the deplorable deadlocks that have characterized the past year. A good omen in that respect is the preliminary report of the President's new Industrial Conference, which we shall discuss later.

Applied Economics

IT IS good advice that the people should be taught economics. It would be well if, instead of our being a nation of economic illiterates, we all knew at least the rudiments. But it is easier to say "teach economics" than to do it, and it does not follow, moreover, that if the people were taught economics they would act in the light thereof.

As to our domestic affairs, the thing desired is that men should be brought to a realization that we cannot have goods without producing them, that no large number of men can hope to profit at the expense of other men, by producing less than they should and getting higher wages than they are entitled to. Suppose every man and every youth were taught the principles of economics, what would be the value except in the application? What would move the individual to act upon the knowledge and alter his conduct?

Applied economics is what is needed, but it is rather difficult to expect much good to come from the individual applying his knowledge of economics once gained. There is a fine opportunity, however, for economic studies to be made and the results or findings to be placed before the public. A great deal of work is now done in the collection of statistics of prices of commodities, whereby the public is given information relating to the cost of living. While it may be of interest to know that in a given period the average price of commodities, or the cost of living, has increased or decreased by a certain percentage, yet it would be much more useful if information were secured as to why the change had occurred. It may be helpful in settling a labor dispute to cite facts as to what it costs the workman to live, but labor disputes frequently arise because the workman is not producing as much as the laws of economics would dictate. Instead of thinking only of what the workman ought to be able to buy with his wages, it would be well to think also of what services he proposes to render for those wages.

This continued dealing in averages, of commodity prices and wage rates, tends to becloud the situation instead of throwing light upon the way out. The public should be informed of specific facts. For instance, coal miners do not work full time. That is economically improper, yet recently the coal miners demanded a 60 per cent increase in their rate for mining a ton of coal, on the very ground that they work less than 200 days in the year.

Individual industries could study their economic results to advantage and those that can make a good showing would find it advantageous to make the facts public. Those that cannot should seek to improve their condition. At present it is easy to show at least one wide divergence in price relations. Thus: Bradstreet's index number of all commodities now stands at 125 per cent above its ten-year pre-war average 1904 to 1913 inclusive. The finished steel prices promulgated March 21, which the United States Steel Corporation has taken the lead in adhering to despite requirements in excess of the supply, are up only 81 per cent. The steel industry does not show this low percentage through having been backward in advancing wages, but rather because the bulk of their men must follow the machinery and therefore have not decreased as much in efficiency as has been the case in some other industries.

Those industries that have exerted the strongest influence in pulling up the index number should be studied to see what is wrong with them.

Fuel Oil Combustion And Conflagration

FOR some time the various municipal authorities throughout the country have been studying the question of legal regulations governing the storage and use of fuel oil. That some kind of rules will shortly be adopted is certain, but whether they will be practical or not will largely depend on the experience and motive of the drafters. Of course if the result desired is an absolute prevention of fuel oil conflagrations, rules can be made with a margin of safety as wide as the ocean. In this case the high cost of engineering and equipment would soon offset any advantages in burning oil as fuel. This would please the city fire chiefs, because most of them are mainly concerned with extinguishing fires and naturally lend their testimony in support of rules which will entirely eliminate oil conflagrations regardless of other important considerations.

The rules as finally adopted should not be influenced by extremists on either side of the question. Men equipped with a far-reaching view of the broad economics of both fuels and fire hazards should assert themselves. There are these among the consumers and producers. The latter, being effectively organized in the American Petroleum Institute, are acting concertedly. It is for the attention especially of the former that we have included a discussion of a tentative draft of regulations in this issue.

Shape of Metallic Crystalline Grains

ON ANOTHER page is printed a portion of Dr. DESCH'S second report on the solidification of metals, in which he discusses some evidence bearing upon QUINCKE'S hypothesis, that immediately before solidification a liquid expels a small amount of immiscible fluid which arranges itself in cell walls, within which solidification of the main mass proceeds. A marked similarity between foam cells and crystals of β-brass disintegrated by mercury is actually found, but crystalline grains of other metals could not be isolated in sufficient number to yield useful data.

While a study of crystalline boundaries developed in a micro-section gives little light upon their spatial dimensions, one cannot help feel that photographs of a succession of parallel sections could be used to build up crystal shapes much as a relief map is constructed from contour lines. Thus, a small block of metal might be placed in a fixture so that successive surfaces could be ground exactly parallel to each other, and a closely referenced area successively photographed at uniform magnification. The thickness of metal removed might be determined by caliper or balance and each micrograph mounted on a sheet of wood of corresponding thickness. This could then be cut apart along the crystal boundaries, and each section glued in correct orientation and position to the corresponding ones from the preceding photographs. A tedious job, but well within the skill of many model makers.

Such solid forms, capable of reproduction, would be of great value in an investigation like this, and would at the same time check various ideas regarding the relation between grain size and counts from a micrograph.

One reservation must always be borne in mind when trying to determine the mechanism of solidification by the use of such crystalline studies, and that is the obvious fact that the history of the metal subsequent to its solidification has a profound influence on the eventual grain shape. It may very well be that the cellular structure of freshly solidified metal is unstable at lower temperatures, and the heat residing in the ingot during cooling is sufficient to modify profoundly its constitution. The efficacy of drastic quenching may not be doubted in some cases, although in others it does not prevent an astounding amount of molecular migration.

A successful conclusion is to be wished for Dr. DESCH'S most difficult problem. It will doubtless yield immense immediate light into the structure of pure metals; it may clear up perplexing and expensive troubles with impurities in melts. But as is usual with that dubbed "pure research," the eventual effect of a clear insight into the mechanism of solidification cannot now be dreamed.

The Forest Products Laboratory Valued Servant of the Industries

GOVERNMENT institutions are akin to business firms in that they have individuality, determined largely by the economic benefit each renders to the population served. If a commercial project is not based on the principles of real assistance to the community, it fails, but on the contrary, as the service becomes of increasing value, the firm prospers in fulfillment of the owner's expectations.

A government organization backed with initial appropriations can, within a comparatively short time, procure results much needed for the public welfare, thus immediately taking its place among recognized institutions.

Then appears a marked difference in the progress of the two, for the business organization receives return directly and almost in proportion to value given, while the government body, the public itself serving the public, enjoys no immediate return to the unit performing. It must needs wait until through general appropriation, involving the long process required to remove money from one pocket to the other, the necessary funds are made available to the institution. The full growth of the deserving government organization is thus frequently hampered in periods of rapid development.

Sharply and distinctly outlined against the background of lethargic governmental departments, standing to the fore in largeness of service and economic return to business industrial, is the Forest Products Laboratory. Published elsewhere in the pages of CHEMICAL & METALLURGICAL ENGINEERING, an article under the title "The Forest Products Laboratory" re-counts in detail some of the things accomplished by this institution. In no less proportion than the ensemble of the industries of the United States, the chemical and chemically controlled industries are benefited by the activities of the Laboratory.

The Laboratory is supported by Federal appropriation amounting to $175,260 annually, for the year beginning July 1, 1919, which is no greater than the pre-war figure. During the war its activities were greatly increased and supported by additional allotments from the War and Navy Departments. These have been largely withdrawn, leaving the organization dependent on the funds inadequate to support the natural growth—inadequate because of the depreciation of the buying power of the dollar—and especially insufficient to cover the necessary research in adaptation of valuable war-time discoveries to peace-time production.

A committee composed of representatives from a number of national associations, covering the industries most vitally interested in the service rendered by the Laboratory, after careful investigation, hold the opinion that an annual appropriation of not less than $500,000 should be made by Congress. The committee further finds that this amount could not be safely reduced without great loss to the public, the ultimate beneficiary of the Laboratory's output.

The cause is worthy, the need for adequate appropriation for housing and maintenance is immediate, and it only remains for the individuals at interest, namely, the whole public, to push the wheels through Congressional representatives. We are glad to lend our support to the movement and urge all engineering and scientific organizations to do likewise.

The Future of Commodity And Property Values

THUS far there has been little trend toward the correction of the anomaly left by the inflation the war caused, of commodity values, in dollars, being increased much more than values of fixed property by comparison with values before the war. It costs about twice as much to build a dwelling house as it did two or three years ago, and perhaps three times as much as 20 years ago, by reason of materials costing more, labor costing much more per day, and labor doing much less work in a day, but on the other hand the houses already built have not increased in market value in any such ratio. Inasmuch as houses have to be built as the population increases and old houses wear out, one would suppose that the value of the old house and the cost of producing a new house would tend to come together.

As to land values the case is different. Land is not produced, but the owner of land expects revenue and he would like to have his revenue buy him as much in commodities or labor as it did before the inflation occurred.

There is to be a resolution of forces, of course, according to immutable laws, but one does not know precisely what the laws are or what are the relative amounts of the forces or their angles.

There are many who argue that the decreased value of the dollar is simply a permanent thing, and all values that are expressed in dollars must be correspondingly increased, if they have not already been increased. The application of the theory, however, encounters difficulties of various descriptions and degrees. There are high school teachers who complain that they are receiving less wages than street sweepers. Possibly that situation can be remedied, but there are many billions of bonds whose holders can of course obtain no relief. Holders of stock may be given relief by dividend rates being increased, or by stock dividends being declared in case the Supreme Court decides that stock dividends are not taxable as income. There is no disposition to double freight and passenger rates, the increases that have occurred being regarded as relatively heavy as it is.

There is always a way to get around things, however, if it is absolutely necessary to get around. In a given industry, for instance, wages advance by an amount out of proportion to the general alignment of affairs, and then the introduction of labor-saving machinery is encouraged, whereby eventually the labor cost of production is brought to a lower level than ever.

There are some restraining influences to the increase in value, measured in dollars, of fixed property. For the purpose of the present argument it does not matter what the influences are. The cost of duplication being greatly advanced, increases in the number of dwelling houses, of power plants and other kinds of property are somewhat discouraged. Correspondingly, there is a greater incentive to secure efficiency from such property as exists or is to be built. More families can be accommodated in apartment houses, with the same capital, than by building separate dwellings. By better design and better machinery power plants can be made more productive.

In other words, efficiency will make greater strides in some quarters than in others. As a rule improvements are forced rather than spontaneous, and where there is the most pressure there the greatest progress will occur. The public service corporation, that cannot double the book value of its property, its charges and its dividend rate, must make its property more efficient.

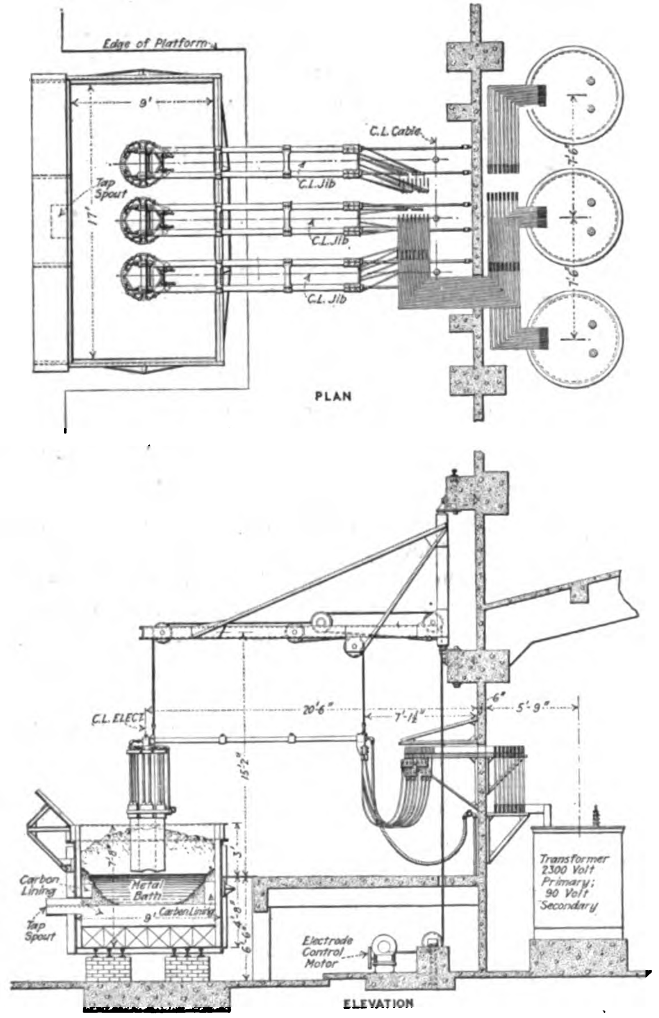
One must remember that the affairs of men are produced by men. It is what is in men's minds. Some theorists would have it that if the amount of the circulating medium is increased by a certain percentage, then all prices will automatically advance by a certain percentage. There is nothing automatic about it. A suggestion along this line is furnished by the New York stock market, which is held to represent actual values, but those wise in Stock Exchange doings assert that "stocks never advance; they are put up." In other words, the shares may be entitled to bring higher prices but they do not bring the higher prices without assistance. Price advances in the commodities that are bought by the general public occur largely according to the mental attitude of buyer and seller. If the seller is courageous and the buyer careless the price advances. If the buyer really cannot afford to pay the advanced price, or curtails his consumption, the price is likely to fall. It would be marvelous indeed for the people to get along at all if all their complaints about "the high cost of living" are really true. The individual complains of the advance in the unit price but says nothing about his ability to get along quite comfortably with a smaller number of units. Eventually there will be found room for commodity prices to come down somewhat, though probably not in this period of strikes, restricted production and general carelessness in spending. Property values, on their part, will probably advance somewhat, and a few years hence commodity and property values will probably be found to be in somewhat the same relation as before the war.

Western Chemical and Metallurgical Field

Silicomanganese Furnace Production Record

SILICOMANGANESE was produced in this country as a result of the war demand for steel deoxidizers. It has the advantage over ferromanganese in that it can be easily produced with a low carbon content and from manganese ores high in silica. Although not used in this country to any large extent, silicomanganese has been very favorably considered and used in quantities in England, France, Russia, the Scandinavian countries and Germany; in the latter country very extensively during the war. It is considered to be a more active deoxidizer than either ferromanganese or ferrosilicon alone.

A furnace was designed and erected by the Beckman & Linden Engineering Corporation of San Francisco during the spring of 1918. The furnace is of the open-top design, rectangular in plan, 9x17 ft. outside dimensions; of 3000-kw. capacity, using 60-cycle, 3-phase current operating at 90 volts between phases. The general design is shown in the accompanying drawing, with dimensions, showing a side elevation and a plan view. The electrodes are hexagonal in shape, 20 in. in diam., this form being chosen as giving better contact between holder and electrode. The flexible conductors from the closed delta are connected to a copper pipe conductor; the electrode, electrode holder and conductors are supported from an overhead jib. The cooling water for the holders flows through the copper conductor pipe. The furnace is tapped by burning through the refractory plug and solidified metal at the tap hole with a graphite rod which is electrically connected to one phase during this operation. Charging is done by hand from the platform, the furnace being of sufficient height above the platform to protect workmen from excessive heat.



3000-KW. SILICOMANGANESE FURNACE

The table gives the consumption of raw materials, electrodes and power for the first fifteen days of August, 1918. Average weight of electrodes 1180 lb. Average analysis of manganese ore charged was 39.5 per cent Mn, 23 per cent SiO_2. The Segundo coke from Colorado, which was used during the test, averaged 14 per cent ash. The entire charge was melted to alloy, no slag being formed. The manganese recovery averaged 93.6 per cent, the loss being caused principally through volatilization.

CONSUMPTION OF RAW MATERIALS, ELECTRODES AND POWER

Date, 1918, Aug.	Silicomanganese Production Lb.	Per cent Mn. in Product	Mn Ore, Lb.	Silica, Lb.	Coke, Lb.	Scrap Steel, Lb.	Electrodes, No. Used, 20 In. Diameter	Power, Kw.-Hr.
1	25,592	53.75	38,600	7,050	17,250	6,345	2	66,200
2	26,894	54.5	36,800	6,900	17,625	6,210	1	66,600
3	25,078	53.25	34,500	6,900	15,750	6,210	2	60,600
4	25,876	54.0	37,500	7,500	16,100	6,750	1	66,500
5	26,940	52.75	37,500	7,500	17,280	6,750	2	68,860
6	23,794	53.0	32,300	6,180	14,970	6,075	2	60,970
7	23,242	53.5	30,000	5,565	11,575	5,835	2	65,290
8	25,080	53.75	36,750	6,860	16,430	7,100	..	67,230
9	20,621	52.25	33,750	6,300	12,350	6,530	1	64,030
10	17,239	53.75	26,250	4,900	9,500	5,075	1	40,220
11	27,053	53.5	37,500	6,720	15,930	6,960	2	57,290
12	22,931	52.75	38,400	6,720	14,985	6,960	1	61,960
13	28,190	53.0	40,000	7,000	17,030	7,250	..	63,850
14	17,837	53.0	27,200	4,760	11,900	4,930	2	58,100
15	22,401	53.0	31,100	4,702	14,050	5,622	1	56,750
	358,768	53.3	518,150	95,557	222,725	94,602	20	924,450
Aver. per 24 hr.,	23,918	53.3	34,534	6,370	14,848	6,307	1⅓	61,630
Aver. per 2240 lb.,	.....	.....	3,235	596	1,403	591	147 lb.	5,770

Average analysis of silicomanganese produced: Mn, 53.30 per cent; Si, 23.12 per cent; Fe, 23.00 per cent; C, 0.40 per cent; P, 0.18 per cent.

Alaska's Mineral Production

Regular mining in Alaska may be said to have been begun in 1880 when the Juneau gold placers were first exploited. Since that time the value of the mineral wealth produced has been estimated at more than $418,000,000. During 1918 the mineral production was valued at $28,254,000, which is less than that for 1917 by $12,500,000. This decrease was chiefly in copper, which fell from 88,783,400 lb. valued at $24,240,598 in 1917 to 69,224,951 lb. valued at $17,098,563 in 1918, the reduced output being due to the shortage of labor and ships. There was also a reduction of the output of gold, silver, lead, tin and tungsten due to scarcity of labor and the high cost of supplies. The production of antimony practically ceased because of the inability of the producers to compete with the cheaper foreign product. The production of coal, however, increased from 53,955 tons valued at $265,317 in 1917 to 75,606 tons valued at $411,850 in 1918. The production of platinum, which began in 1916, continued on an increasing scale.

According to current reports from the U. S. Geological Survey, twenty-eight gold dredges produced $1,450,000 worth of gold from 2,490,000 cu.yd. of gravel. In 1917, 36 dredges handled 3,700,000 cu.yd. of gravel and recovered gold worth $2,500,000. The total value of the gold produced by dredges to the end of 1918 is estimated to be $19,035,000. The value of the placer gold produced in 1918 was about $5,900,000, compared with $9,810,000 in 1917. The output of platinum, palladium and other metals of the platinum group for 1918 is estimated at 284 fine ounces valued at $36,600. Substantial amounts of palladium and some platinum are recovered from the copper ore of the Salt Chuck Mine, near Ketchikan.

The tin mines of Alaska produced 136,000 lb. of metal valued at $118,000 during 1918, a decrease of 64,000 lb. from 1917. During the year only one dredge was operated. A recent discovery of placer tin has been reported from Potato and Humboldt creeks, on the Seward Peninsula, and from Moran Creek, a tributary of Melozi River, where gravels are said to contain 2½ lb. of tin and 10c. worth of gold to the cubic yard.

The Alloys Research Association

THE Division of Industrial Research of the National Research Council, after a careful canvass of the situation and the many problems which merit immediate attention, has decided that perhaps the greatest number could be served by the formation of a coöperative association to engage in fundamental research in alloys. The Division fully recognizes the fact that a great deal of exceedingly valuable work has already been done in the alloy field, but it is also convinced that progress in many lines of manufacturing is arrested because of the lack of certain facts which are fundamental and that the solution of a number of manufacturing problems depends upon additional information which can only be obtained by intensive research.

The Division believes that these problems are so broad that no single organization or laboratory can profitably do the work as thoroughly as it needs to be done, and that the most satisfactory method is for the industry to undertake the work under its own control and at its own expense. The whole question has been discussed thoroughly by the Division itself, most of whose members are men with commercial experience and connection, and the provisional outline submitted below has been formulated with the co-operation of those men who are most familiar with conditions in the alloy field and who are themselves very closely identified with the remarkable progress which has thus far been made. These specialists represent both the users of alloys and those whose primary business it is to manufacture alloys for sale as raw materials.

The Division has been encouraged in its work by the excellent records made in those industries which have supported research on some co-operative plan, notably, the National Canners Association and the Malleable Iron Manufacturers. In addition, a number of fellowships have been supported by associations and manufacturers in special fields with successful results and a substantial profit to themselves. It has been demonstrated that the most progressive concerns, which are commonly supposed to require no further assistance in research, frequently derive the greatest benefit due to their ability to apply the results of the association to better advantage in their own works.

This new organization, which will be known as the Alloys Research Association, will undertake systematic research into fundamental questions affecting pure metals and alloys, both ferrous and non-ferrous. An information service will be maintained to supply members with summaries of technical information in the metal field, answer inquiries and assist the research workers by preparing monographs on each phase of a proposed research, analyzing and recording results of research, and editing material for publication.

The membership of the association will include individuals, institutes and other associations interested in the production and use of alloys as raw materials in manufacturing processes. Initially, each individual member will pay $1000 annually for a minimum period of five years, while an institute will be assessed a larger sum, depending upon the extent of its membership and the importance of alloys to it. Upon recommendation of the Executive Board, problems of general interest will be studied at the expense of the association and the results made available to all members. A member may also have undertaken a problem in which he alone is interested, at cost, for his sole benefit.

Undoubtedly a special laboratory will sooner or later be required, but until the results of the work warrant it, it is proposed that existing laboratories be used whenever possible.

Every effort will be made to avoid duplication between the work of the association and that of other agencies in the field. Through the services of the Advisory Committee on Alloys Research, of which Mr. W. M. Corse is chairman, it will be possible to keep in touch with work now in progress or contemplated and the activities of the association be so guided as to coöperate with such work.

The proposed articles of association, which have been briefly summarized here, are set forth as tentative and provisional, for the purpose of inviting discussion and constructive criticism. Those interested are urged to contribute their views to the vice-chairman of the Division, addressing H. E. Howe, National Research Council, 1201 Sixteenth Street, Washington, D. C., at their early convenience.

The Robert W. Hunt Award

Capt. Robert W. Hunt has placed in trust in a Chicago bank the sum of $5000 to establish payment of what is to be known as the Robert W. Hunt Award, $250 of which will be paid each year for the best paper contributed to the *Proceedings* of the Western Society of Engineers on any subject pertaining to the manufacture or treatment of iron or steel products. The purpose of this award is, in the main, to make membership in the Western Society of Engineers attractive and useful to the younger men of the profession.

The conditions in general which surround the award of this sum are that the member must not be over 30 years of age or a member of the faculty of an educational institution. The decision of the award shall be given to a committee of three, said committee to be annually appointed by the president of the Western Society of Engineers. One member of this committee shall be a man of recognized experience and established reputation in the manufacture of iron or steel. If in order to obtain such a member for the committee it is necessary for the president to go outside of the membership of the Western Society of Engineers, he shall be authorized to do so.

If in the opinion of those upon whom the allotment shall rest there should not have been contributed during the year any paper worthy of the award, the trust company shall pay the year's interest to the proper authorities of St. Luke's Hospital.

An Innovation in Insurance for Chemical Plants

EXPANSION in chemistry is coming into view on every side. The latest addition is the establishment of a department of chemical risks by four associated fire insurance companies, namely, the North British and Mercantile Insurance Co. of New York, the Pennsylvania Fire Insurance Co. of Philadelphia, the Commonwealth Insurance Co. of New York and the Mercantile Insurance Co. of America, also of New York.

For many years it has been the custom among fire underwriters to classify "chemical works" as a group by themselves, and to consider them as abounding in unknown and incalculable hazards, and to write very modest lines of insurance upon them. In view of its status as a key industry and of the economic need of chemical manufacturers for indemnity in the event of loss, the above-mentioned insurance companies appointed W. D. Grier to look into the subject generally, to see how much business there was, and if it would be worth while to establish a special underwriting department to extend service to chemical industries, such as is given to manufacturing concerns under sprinkler protection, with a constant view to decreasing the fire hazards.

The investigation showed a great deal to be done, and these companies organized a special Chemical Department, Mr. Grier being put in charge. It is believed that they are the first to organize such a department, the object of which is to give fire protection engineering service to chemical industries, looking to elimination of unnecessary risks and consequent loss and interruption of manufacture. This is done without charge to parties assured.

Mr. Grier's investigations brought out some of the defects in installation which are found more or less frequently. Among them are the following:

In regard to such inflammable liquids as benzene, etc., the method of storing is always a matter of interest, and so also is the installation of piping, with the risk of a break in the connections and a resulting fire that is mean to handle.

Arrangements for warming tank cars are often defective and dangerous.

There are frequently found defective fuel oil systems and these cause fires.

Apparatus provided with direct heat often have defective furnaces.

Oil baths are often improperly installed and carry considerable risk.

Nitration may be inadequately isolated and defective methods of nitration are occasionally discovered.

The methods of handling highly inflammable or explosive substances need careful study in each case, and the same may be said of the care of intermediates that are of an impermanent nature.

A frequent source of trouble is the defective venting of inflammable fumes.

Many grinding processes involve serious fire hazards.

The storage of finished products should not be in proximity to the hazard of fire by contagion. This would seem to be self-evident, but it is often forgotten, and the greatest risks and the greatest values are often found together. Sometimes a little flash will open a lot of sprinkler heads and wet down goods of large value. This makes a difference between no claim at all, or possibly $25 or $50 on the one hand, and $40,000 or $50,000 on the other.

Service parts such as washrooms, toilets, baths, clothes lockers, etc., are often the starting place of fires.

Electric wiring systems suffer deterioration from acid or other fumes, and fires result from cross circuits.

In other words, there is an insurance engineering angle of attack that is often otherwise overlooked, and it is the effort of Mr. Grier and his associates to overcome this neglect. Sometimes the best method of meeting the situation is by making the buildings, as in a powder mill, small and scattered, and to provide heavy outside protection to keep the fires confined to a single unit in each case.

The laboratories of the National Board of Fire Underwriters at Chicago have been doing excellent work in this connection for many years, but the managements of these companies are to be congratulated on their progressive spirit. Once upon a time there was stored in Liverpool, as recollection serves, a large quantity of cotton in the ground floor of a warehouse, and a large quantity of nitrate of soda on the floor above, under the roof. The roof leaked, and the merchandise remained in storage a long time. The fire that ensued was a surprise. There are some fire underwriters who would still be surprised at it.

Brass Founding Methods in Germany

Recently a deputation of men connected with the British Brassfounders Association visited German works in the Rhineland, and, according to the *Iron and Coal Trades Review*, have reported that the main advantage the German has is in the smaller variety of articles produced by each manufacturer, namely, greater concentration on output, resulting, of course, in a larger turnover, combined with that careful attention to the details of manufacture which is a characteristic of the German, from the head to the humblest employee.

The casting methods appear to offer the greatest divergence from the English system, and while both hand and machine molding appears to be employed very generally, the following differences may be particularly noticed: It appears to be the common practice in all brass foundries to put the molds in an oven as soon as they are made and leave them there until the next day, such molds being taken from the oven the next morning and poured during the day and the oven again refilled for drying a new lot the following night.

Both pit furnaces and tilting furnaces are used for melting, several bessemer-type tilting furnaces made of iron and lined with brick being noticed, this system avoiding the use of crucibles except as a medium for carrying the metal from the furnace to the molds; in some cases the ladles are of iron. The molds when cored up are placed on top of each other into a pile three or four feet high, and the whole bolted together, after which they are laid on end for pouring in the usual way. It also seems a common practice for the castings to be cut off the runners when cold by means of a sprue cutting machine. In one works where hand molding was in progress, in place of using mallets a heavy metal ball about 7 in. in diameter and weighing nearly 50 lb. was rolled all over the mold in order to compress the sand, and this method would possibly insure more regular pressure for work which does not vary too considerably in height. It was also noticed in several instances that loose locating pegs were inserted in the sand of the mold to assist in the accuracy with which the molds were matched.

The Whole U. S. Patent System in Danger

WHEN the Government Printing Office sets up and prints everything that a Senator or Congressman says when he is talking against time to defeat a desirable bill which will pass if his wind gives out, for the merit of which his own party cannot get the credit, it does seem to be about the most useless typographical establishment in the world. But occasionally its publications are of lively interest, and of these we commend a book entitled "Hearings Before the House of Representatives of the 66th Congress, First Session, on H.R. 5011, H.R. 5012 and H.R. 7010. It covers 320 pages, and every bit of it is interesting.

The system of granting an inventor a 17-yr. monopoly for his invention for a comparatively small fee originated in the United States, and its immediate effects were good. These were not measured by the prosperity of the inventors; they were made manifest in the greatly increased number of useful inventions which were recorded in response to the encouragement provided by the system. This was so marked that all the progressive countries of Europe, save those of Latin origin, adopted methods similar to those of this country. The peculiarity of these methods consists in a careful examination of each invention, more particularly as to its novelty, before the patent right is granted. In Latin countries but little more than a system of registration is in effect. Anybody may register what he claims to be an invention by paying the fee, and then he must establish his rights afterward, if he can. This so-called French method has not been found to work well in regard to real inventions.

Switzerland and Holland tested out the plan of having no patents at all. Both found that without a patent law the incentive to follow up and manufacture new things was lacking, and that progress in this respect declined rather than increased. Later both countries enacted patent laws based on the system in force in America.

THE MERIT OF PATENTS

The merit of patents seems to be due to several related causes. To introduce anything new usually requires time, energy and expense, in which time and energy may also be expressed in terms of expense. Without a monopoly for a given time the inventor or owner of the patent must nevertheless undertake or provide for the cost of introduction, after which any competitor may reap the same benefit as he. Without a patent the inventor is at a disadvantage, because any competitor can reap his reward without paying the price of introduction for it. The premium on novelties takes a precipitous dip as soon as we pass the millinery business, and it becomes a charge as soon as we reach materials and machinery. The lack of a patent system makes invention a liability rather than an asset. On the other hand, when an inventor publishes his invention in a patent he becomes the nation's teacher; he stimulates enterprise and encourages more invention. Fundamental patents are always followed by a large number of applications from new sources relating to improvements in detail. And we must remember that after an invention has been a monopoly for 17 years it becomes the property of the people.

What our Patent Office suffers from is neglect—Congressional neglect. We shall endeavor to show its most pressing requirements.

As soon as the National Research Council found itself it appointed a committee to consider the matter of patents. These gentlemen were William F. Durand, chairman; L. H. Baekeland, acting chairman in Dr. Durand's absence; M. F. Pupin, R. A. Milliken, S. W. Stratton, Reid Hunt, F. P. Fish, ex-Commissioner Thomas Ewing, and Edward J. Prindle. They proposed the three bills under discussion, which are now in the hands of the Committee on Patents. We shall consider their provisions after we have discussed the situation.

SHABBY TREATMENT OF PATENT EXAMINERS

In our issue of Sept. 1 we spoke editorially of "Shabby Treatment of Patent Examiners." In 1848 the salary of each primary or chief examiner was fixed at $2500, or the same as that of members of Congress. It was held that as the examiners must be men of professional education and training, their habits of life and requirements would be about the same of those of Congressmen. Their responsibilities are very great; a single error may involve millions of dollars in expense, and do incalculable injustice. The cost of dishonesty would also be beyond computation. The salary of these same primary examiners is now $2700. Since 1848, Congressmen have raised their own salaries from $2500 to $7500, and those of principal examiners from $2500 to $2700. There are 45 primary examiners, and 360 first, second, third and fourth assistant examiners receiving respectively $2400, $2100, $1800 and $1500 each per year. The force includes 7 doctors of philosophy, 18 doctors of medicine, 1 doctor of dental surgery, 21 mechanical engineers, 19 electrical engineers, 19 civil engineers, 2 chemical engineers and hundreds having masters' and bachelors' degrees. Few good examiners will remain at these figures, except those that are staying on out of loyalty and love of the work. The Commissioner is required to fill vacancies with temporary appointees, because the Civil Service Commission cannot induce enough good men to try for the positions. So much for salaries. The work is rapidly running behind, and it is falling off in quality. Nevertheless this same corps of examiners is the very key to our entire patent system. Every neglect, every mistake on an important invention invites long, expensive litigation and hinders a poor inventor from obtaining his rights.

ANOMALOUS POSITION OF THE PATENT OFFICE

The Bureau is in charge of the Secretary of the Interior, although it can hardly be said to be under his authority. He represents it, but he does not control it. His approval is required for changes in the rules of practice, but he has no power to compel changes, or to organize improvements. There is nothing in common between the interests of the Interior Department and the Patent Office. Its situation is in the Interior Department, but not of it. The result is the Patent Office is either left out in the cold, or its needs are judged in connection with the requirements, for instance, of the Pension and General Land Office—and this through no fault of the Secretary of the Interior either. The Congressional Mind builds up its own theories.

In regard to patent litigation we have this situation: The calendar of the Supreme Court is so crowded that no patent suits will be considered by it, save in very rare instances. The right of appeal except under a writ of certiorari which involves the willingness of the court to hear the case was taken away in 1891. The final courts of adjudication in patent cases, therefore, are in effect the nine United States Appellate Courts of concurrent jurisdiction. Therefore if either party to a patent suit is dissatisfied with the decision of one of the nine Circuit Courts of Appeal, he may try the suit out again in any one of the eight others, and thus keep up the misery for an insufferably long time. Let us quote from the address of Mr. Frederick P. Fish before the committee. He said: "If either the plaintiff or the defendant in a patent suit loses his case, he says to himself that the particular court in which his case was decided only controls the territory, for instance, of the First Circuit—Maine, New Hampshire, Massachusetts and Rhode Island—and that he may be able to get a different decision in a different part of the country. He has every inclination to try his luck in Ohio or New Jersey or somewhere else, and very frequently when the plaintiff is beaten he will go into another court in another section of the country, and try the case over again. In like manner infringers in other circuits will go on as before, hoping for a different result in a new case against them."

This is an exceedingly unwholesome condition of affairs. It also stands to reason that, with the best of intentions, some judges are quick to understand the points at issue in a patent suit, while others have difficulty in achieving a clear vision of the same problem.

DAMAGES THE LAST THING EXPECTED

Under present conditions when a patent suit is decided and, let us say, infringement is proved to the satisfaction of the court, an injunction is issued. But damages may not be obtained save in very rare instances. Usually it is held that the exact amount of damages must be proved. It is seldom that a patent covers the whole of an article that is sold, so that the plaintiff must figure out and prove the exact sum involved—which of course he can't. And in default of precise figures the usual award is six cents. The law has ways of its own. Recently there have been two or three decisions in which the courts have taken a more liberal attitude and awarded a reasonable royalty, but it is admitted by lawyers that it will take a whole generation to induce the United States courts to adopt this position generally, unless special provision is made for it by legislation. As things are, about the last thing a plaintiff in a patent suit expects to get is damages.

THE LEGISLATION PROPOSED

The proposed legislation remedies all these features. It provides for a new court of seven members to sit in Washington. The Chief Justice is to be appointed for life by the President, thus giving to the court an element of continuity. The other judges are to be selected by the Chief Justice of the United States from the various District and Circuit Judges throughout the land, and are to serve for six years each, three to be appointed every three years. This would assure the appointment of judges who had experience in patent litigation, but their rotation in office would avoid the likelihood that the court become narrow in its views, owing to the nature of its work. It would also provide that the judges come from various communities, and thus the charge that any special interests might have had a hand in the appointment would be avoided. They are to be adequately paid, the Chief Justice at the rate of $12,000 a year, and the Associate Justices $11,500 each. The establishment of a Court of Patent Appeals has been advocated by the American Bar Association for many years. It would put backbone and dignity into our patent system.

Another bill increases the salaries of members of the Patent Office staff so that, for instance, principal examiners now getting $2700 will receive $4000, and the first, second, third and fourth assistants respectively $3300, $2700, $2200 and $1800 each. Other salaries are in proportion and are no more than commensurate with those paid in other and unforgotten departments of the Government. Other countries—Great Britain and Holland, as was brought out in the hearings—pay their examiners and staff much better than we do.

Another bill makes the office an independent bureau, and provides also that "If proof is not offered, or in the absence of adequate proof of the amount that should be awarded as damages or profits, the court, on due proceedings had, may adjudge and decree to the owner, payment of a reasonable royalty or other form of damages." In other words, it substitutes a reasonable royalty for six cents.

Every feature of these bills is of prime importance, and is of interest to the people as a whole. Under our present defective system it usually takes from six to eight years to find out whether an important patent is valid or not. Under the proposed changes, one and a half years should be the maximum time, save in extraordinary cases. Under present conditions, unless a man has vast wealth back of him he cannot afford patent litigation against a rich offender. That is a situation so radically wrong and so contrary to the temper of the times that it is not even the part of good citizenship to endure it.

PEOPLE SHOULD AWAKE TO THE SITUATION

Many persons refuse to take the trouble to read anything about patents on the ground that they are not interested. But that is a fault of neglect. It isn't so much that inventors need to be protected; it is an unfair situation that has come into being because of Congressional neglect that threatens the peace and general welfare. The present uncertainty and expense of maintaining a patent are very costly, and the money to pay for it in the end comes out of the pockets of the public—and swells the cost of living. Patent business is everybody's business for this reason, and because it encourages invention. Therefore we have no right to sit still and twirl our thumbs while one of our important and needed institutions goes to seed—and sows dragon's teeth in the process.

It is generally admitted by men of experience in Washington that the best way to reach the Congressional Mind is to write from a Congressman's district to him. If we can induce our readers to write to their representatives in Congress urging them to support the bills mentioned, H.R. 5011, H.R. 5012 and H.R. 7010, we believe we shall have contributed an important service.

The Forest Products Laboratory

A Government Institution Serving the Public Both Directly and Through Valuable Data Furnished to Engineers, Architects and Industrial Concerns—Research in Methods of Mechanical Application and Chemical Derivatives of Forest Growths

BY CHESTER H. JONES

THE Forest Service of the United States Department of Agriculture maintains the Forest Products Laboratory, located at Madison, Wisconsin, and operating on industrial research in all applications and uses for products of the forest. Funds for the support of this work are at present appropriated by the Department of Agriculture and the Army and Navy Ordnance and Air Services. The University of Wisconsin furnishes the buildings (Fig. 1), together with heat, light and power. The officials and operators are all on the Government payroll.

The facilities are at the service of any individual or firm that wishes to use them. Contact with the industries and public is continued through personal visits to Madison, correspondence, official publications, and articles appearing in the periodical press. The laboratory is open to visitors, both those who have a general interest and those who wish to spend some time in working out specific problems. Every effort is made to give full and complete answers to inquiries made by correspondence.

Any one may request that his name be placed upon the mailing list to receive future publications on special subjects as they are issued. The Superintendent of Documents, Government Printing Office, Washington, D. C., distributes "Price List 43, Forestry," which covers all publications of the laboratory. The bulletins are to be had free at Madison until the supply at hand has been exhausted. About once a month the laboratory issues mimeographed sheets called "Technical Notes." These are brief summaries of the recent work, written especially for the busy man who is interested in results.

IMPORTANCE OF FOREST RESEARCH

A great deal has been written in the technical and popular press about the importance of our forestry problems, and we have all been impressed in a general sort of way. In order really to appreciate the value of research in forest products to the industries dependent upon them and consequently to our universal welfare it is necessary only to witness the work in progress at the Madison laboratory. The visitor becomes impressed with the thought that there can scarcely be an individual Government organization whose work is of more worth to our commercial life.

In a recent article[1] reference is made to the subject in part as follows:

"With a total annual cut of 40,000,000,000 ft. board measure of merchantable lumber, another 70,000,000,000 ft. is wasted in the field and at the mill. In the yellow pine belt the values in rosin, turpentine, ethyl alcohol, pine oil, tar, charcoal, and paper stock lost in the waste are three or four times the value of the lumber produced. Enough yellow pine pulp-wood is consumed in burners or left to rot to make double the total tonnage of paper produced in the United States. Meanwhile, our paper-makers memorialize the community on the scarcity of paper stock, and pay $18 a cord for pulpwood which they might buy for $3 a cord."

With such quantities as this in mind it can easily be seen that each small finding of the laboratory may be great and far reaching in ultimate commercial result.

CO-OPERATIVE WORK

It is the policy of the Forest Service to obtain to as large an extent as practicable the co-operation of the wood-using industries most directly concerned with the subjects or problems under investigation. The exact terms of this co-operation are determined in each specific case. The investigation of a subject is generally not regarded as complete until results obtained experimentally are checked on a commercial scale to determine the industrial application. When this has been done, further co-operation covering the same ground is not entered into.

The laboratory will furnish such general advice and assistance to any one interested as are available in the files covering previous work, such as design, construction and operation of commercial plants for wood preservation, distillation, kiln drying, etc. In some cases approximate costs and suggested plans and specifications may be given. The laboratory may examine methods in existing plants and recommend improvements.

In cases of active co-operation, a remuneration to the Service is expected, equivalent to the total cost of the work done for the co-operator, including both time and expense of members of the laboratory organization detailed on the project. Such remuneration may be reduced by the extent to which the work is strictly experimental and of value to the Service rather than to the co-operator. When practically all the work proposed is investigative, the laboratory having little or no expert knowledge on the subject to begin with, and the results will be of value chiefly to the general public, the charge to the applicant may be comparatively low or eliminated altogether.

As far as practicable co-operative projects will be covered by written agreements. Such agreements are required whenever co-operative investigations of a specific character are to be continued over a period beyond six months or at a cost to the laboratory of over $100.

Reference to the chart (Fig. 2) will give a clear idea of the organization of the Service, and the type of research work done by the laboratory is shown under "Technical Industrial Research Problems." The views in Fig. 1 show the buildings employed to house the operations. The main building contains the general business offices, the chemical and physical laboratories, the paper plant, the glue laboratory, the wood distillation and preservation laboratories, and several of the drying kilns. A comprehensive exhibit embracing nearly every wood specimen known, together with the library and files, is also in this building. The files contain complete records of the work, and "Technical Notes" is issued by an editorial staff.

---

[1] "Developing the Estate," by Arthur D. Little, *Atlantic Monthly*, March, 1919.

The yard has the lumber stock, drying kilns, and small buildings where additional operations are in progress. Among these are the box-testing laboratory, the pulpwood digesters, the fire-proofing test house, etc.

The other buildings shown are occupied by a large amount of equipment and machinery for carrying out the mechanical tests on various woods, and for the manufacture of propellers and structural parts for airplanes. The latter work became highly developed during the war period and will be continued for the Army and Navy Air Services.

The whole aim of the Forest Products Laboratory effort is to promote economy and efficiency in the utilization of wood and in the processes by which forest materials are converted into commercial products.

PULP AND PAPER

The laboratory is very well equipped for research in the field of pulp and paper. A complete experimental paper mill with Fourdrinier and cylinder wet ends, two presses, nine drying rolls and a calendar stacker produces paper up to 12 in. in width. Necessary paper-testing apparatus is avaliable in a room where the atmosphere is regulated by a small Carrier Engineering Corporation machine. The digester house is arranged with apparatus for sulphite and sulphate pulp. Fig. 3 shows tumbling soda and sulphate digester in which coniferous woods are converted into wood cellulose for nitration purposes without need of additional purification. Sulphite wood cellulose is also purified in this digester. Fig. 4 shows the upper portion of the sulphite digester with the liquor tank on the left and, on the extreme right, the vat for receiving pulp blown from digester.

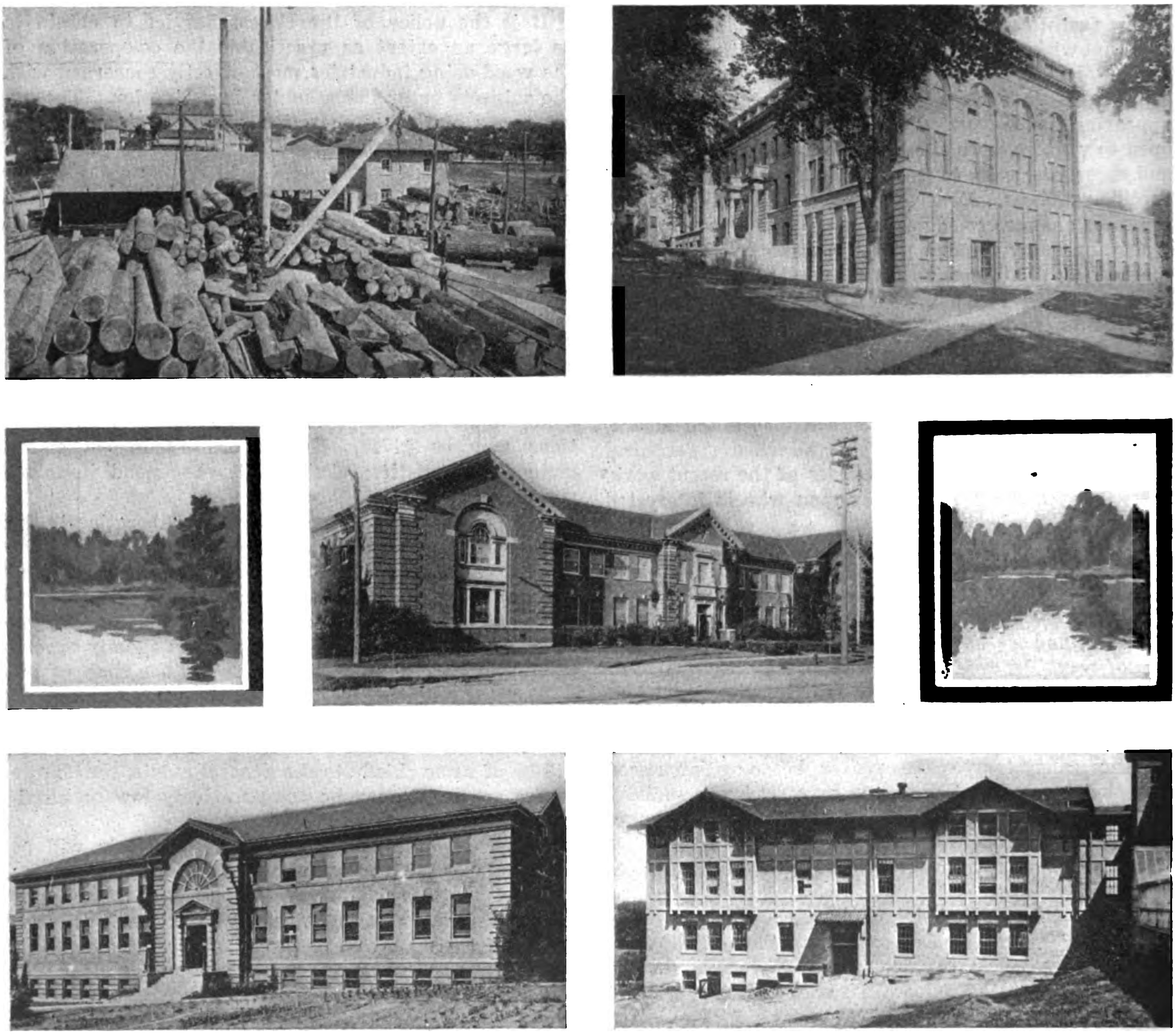
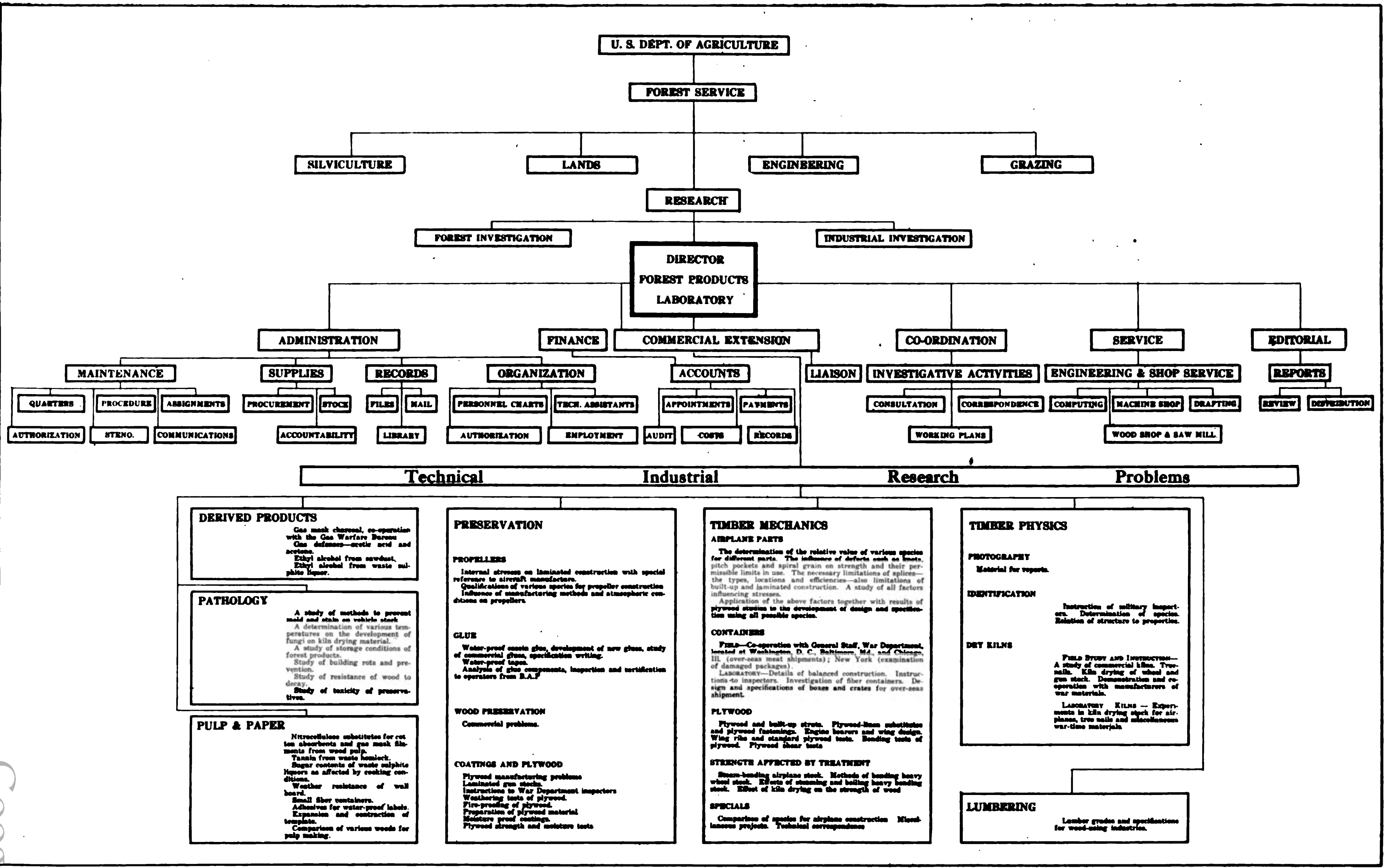


FIG. 1. THE FOREST PRODUCTS LABORATORY

Upper Left—Receiving and storage yard. Upper Right—Where airplane parts are tested. Center—Main building. Lower left —Where the mechanical properties of woods are determined. Lower Right—Building used for experimental propeller manufacture.


U. S. DEPT. OF AGRICULTURE
FOREST SERVICE
SILVICULTURE
LANDS
ENGINEERING
GRAZING
RESEARCH
FOREST INVESTIGATION
INDUSTRIAL INVESTIGATION
DIRECTOR FOREST PRODUCTS LABORATORY
ADMINISTRATION
FINANCE
COMMERCIAL EXTENSION
CO-ORDINATION
SERVICE
EDITORIAL
MAINTENANCE
SUPPLIES
RECORDS
ORGANIZATION
ACCOUNTS
LIAISON
INVESTIGATIVE ACTIVITIES
ENGINEERING & SHOP SERVICE
REPORTS
QUARTERS
PROCEDURE
ASSIGNMENTS
AUTHORIZATION
STENO.
COMMUNICATIONS
PROCUREMENT
STOCK
ACCOUNTABILITY
FILES
MAIL
LIBRARY
PERSONNEL CHARTS
TECH. ASSISTANTS
AUTHORIZATION
EMPLOYMENT
APPOINTMENTS
PAYMENTS
AUDIT
COSTS
RECORDS
CONSULTATION
CORRESPONDENCE
WORKING PLANS
COMPUTING
MACHINE SHOP
DRAFTING
WOOD SHOP & SAW MILL
REVIEW
DISTRIBUTION
Technical Industrial Research Problems
DERIVED PRODUCTS
PATHOLOGY
PULP & PAPER
PRESERVATION
TIMBER MECHANICS
TIMBER PHYSICS
LUMBERING

DERIVED PRODUCTS

Gas mask charcoal, co-operation with the Gas Warfare Bureau

Gas defenses—acetic acid and acetone.

Ethyl alcohol from sawdust.

Ethyl alcohol from waste sulphite liquor.

PATHOLOGY

A study of methods to prevent mold and stain on vehicle stock

A determination of various temperatures on the development of fungi on kiln drying material.

A study of storage conditions of forest products.

Study of building rots and prevention.

Study of resistance of wood to decay.

Study of toxicity of preservatives.

PULP & PAPER

Nitrocellulose substitutes for cotton absorbents and gas mask filaments from wood pulp.

Tannin from waste hemlock.

Sugar contents of waste sulphite liquors as affected by cooking conditions.

Weather resistance of wall board.

Small fiber containers.

Adhesives for water-proof labels.

Expansion and contraction of template.

Comparison of various woods for pulp making.

PRESERVATION

PROPELLERS

Internal stresses on laminated construction with special reference to aircraft manufacture.

Qualifications of various species for propeller construction

Influence of manufacturing methods and atmospheric conditions on propellers.

GLUE

Water-proof casein glue, development of new glues, study of commercial glues, specification writing.

Water-proof tapes.

Analysis of glue components, inspection and certification to operators from B.A.P.

WOOD PRESERVATION

Commercial problems.

COATINGS AND PLYWOOD

Plywood manufacturing problems
Laminated gun stocks.
Instructions to War Department inspectors
Weathering tests of plywood.
Fire-proofing of plywood.
Preparation of plywood material
Moisture proof coatings.
Plywood strength and moisture tests

TIMBER MECHANICS

AIRPLANE PARTS

The determination of the relative value of various species for different parts. The influence of defects such as knots, pitch pockets and spiral grain on strength and their permissible limits in use. The necessary limitations of splices—the types, locations and efficiencies—also limitations of built-up and laminated construction. A study of all factors influencing stresses.

Application of the above factors together with results of plywood studies to the development of design and specification using all possible species.

CONTAINERS

FIELD—Co-operation with General Staff, War Department, located at Washington, D. C., Baltimore, Md., and Chicago, Ill. (over-seas meat shipments); New York (examination of damaged packages).

LABORATORY—Details of balanced construction. Instructions to inspectors. Investigation of fiber containers. Design and specifications of boxes and crates for over-seas shipment.

PLYWOOD

Plywood and built-up struts. Plywood-linen substitutes and plywood fastenings. Engine bearers and wing design. Wing ribs and standard plywood tests. Bending tests of plywood. Plywood shear tests

STRENGTH AFFECTED BY TREATMENT

Steam-bending airplane stock. Methods of bending heavy wheel stock. Effects of steaming and boiling heavy bending stock. Effect of kiln drying on the strength of wood

SPECIALS

Comparison of species for airplane construction Miscellaneous projects. Technical correspondence

TIMBER PHYSICS

PHOTOGRAPHY

Material for reports.

IDENTIFICATION

Instruction of military inspectors. Determination of species. Relation of structure to properties.

DRY KILNS

FIELD STUDY AND INSTRUCTION—A study of commercial kilns. Treenails. Kiln drying of wheel and gun stock. Demonstration and co-operation with manufacturers of war materials.

LABORATORY KILNS — Experiments in kiln drying stock for airplanes, tree nails and miscellaneous war-time materials.

LUMBERING

Lumber grades and specifications for wood-using industries.

FIG. 2. ORGANIZATION OF THE FOREST PRODUCTS LABORATORY SERVICE

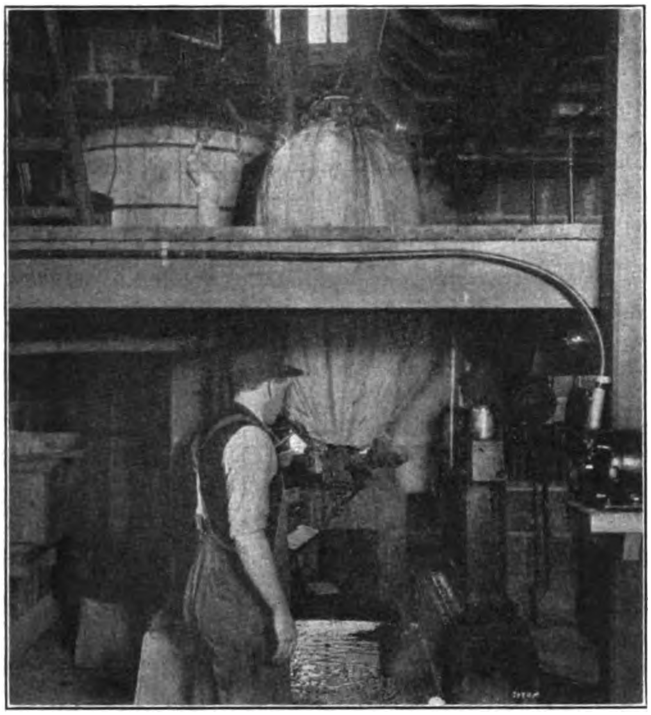


FIG. 3. SODA AND SULPHATE DIGESTER

The problem of lining an experimental digester is different in many respects from lining problems in the commercial sizes, the most important difference being due to the size. Other differences arise from the fact that in order to obtain quantitative yields, the experimental digester must be washed free from pulp immediately after each blow, and a lining which spalls off and produces a dirty pulp is unsatisfactory. It is out of the question to riffle the pulp and obtain reliable yields.

Many different kinds of linings were installed before a satisfactory one was found. Because of difficulties due to size, tiling similar to that used in larger sizes could not be used. Lead was first tried, but was soon discarded on account of the "creeping" action when subjected to temperature variations. Bronze produced dirty pulp. A solid lining of litharge and glycerine lasted only a short time. Then cement briquets were made of many mixtures, given different coatings, and subjected to the action of sulphite cooking acid. The results of these experiments led to the installation of a lining of 1 to 1 cement and crushed quartz sand, 3 in. thick and coated with sodium silicate. This held up fairly well for some time, though particles of sand were constantly falling off and causing dirty pulp.

It was finally decided to install a solid stoneware casting of acid-proof tile 1½ in. thick. This offered no difficulties of construction, as the digester is joined in the middle. Liberal tolerances were allowed in all dimensions, and openings difficult to locate were left out in the casting, being chiseled out after the casting was in place and backed by cement. This lining proved to be exceedingly satisfactory.

FUTURE WORK ON PULP AND PAPER

The work of this section completed to date covers the valuation of fifty specimens of American woods for chemical pulp and twenty-five for mechanical pulp; the manufacture of Kraft paper from native woods which can compete with imported pulp; the manufacture of roofing felt from spent hemlock bark; the reduction of 15 per cent waste in the making of ground wood pulp; the reduction of 30 per cent in steam used and 20 per cent increase in density of black liquors in the sulphate and soda processes; the development of a reliable method for determining the tearing strength of paper; the invention of a recording density hydrometer for use in control of soda recovery; and the production of tannin from waste hemlock bark at paper mills.

The future work under consideration will cover the development of standard methods for the purchase of pulp-wood and other raw materials, and their commercial adoption; study of problems in the recovery of waste from the chemical processes, and the use of black liquors, waste sulphite liquors and similar by-products; continuation of work on lumbering wastes and additional species of American woods for pulp and paper; and co-operation with the pulp mills in working out the application on a mill scale of improvements in processes and methods suggested by experience.

Extension of the use of wood-pulp is also under way. This involves the suitability of the species in the manufacture of twine, artificial silk, rugs and textiles, fiber packing containers, articles molded from mixture of asphaltum and pulp, nitrocellulose, gas mask filters, and many other applications.

PRESERVATION—GLUE AND PLYWOOD

One of the most valuable developments in this department is the manufacture of glue and plywood. The glue is a factor nearly as important as the wood itself, because the finished product is directly dependent for its efficiency on the quality of the glue used in its construction. The uses for plywood are unlimited and its increasing employment in the industries operates directly in the conservation of wood wastes.

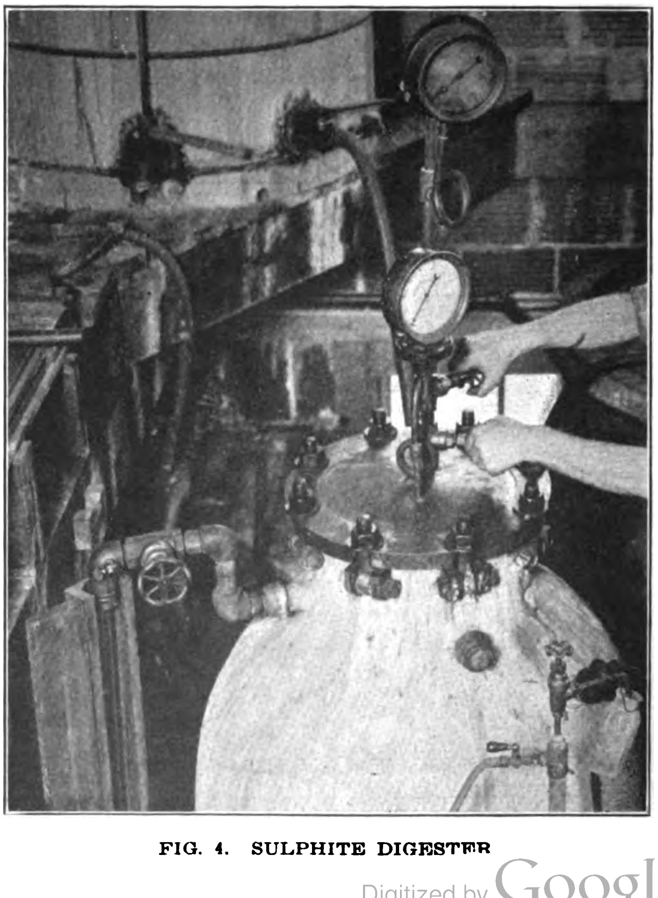


FIG. 4. SULPHITE DIGESTER

It is expected that the next few years will see a marked increase, not only in the use of plywood but in its form of manufacture and its application to various uses. The laboratory has developed new economical and practical manufacturing methods and standard tests to secure uniformity of product, and has determined the suitability of woods heretofore unused for plywood.

Work is yet to be done along these lines and the results will be the basis for the intelligent use of plywood. It has even been predicted that there will be upon the market within a few years houses of the "ready-built" design made almost entirely of plywood construction.

The research work on glues consists of the development and improvement of water-resistant glues, study of commercial glues, analyses and specifications for glue components, glue strength and durability tests, plywood manufacturing problems, and instruction of industrial representatives.

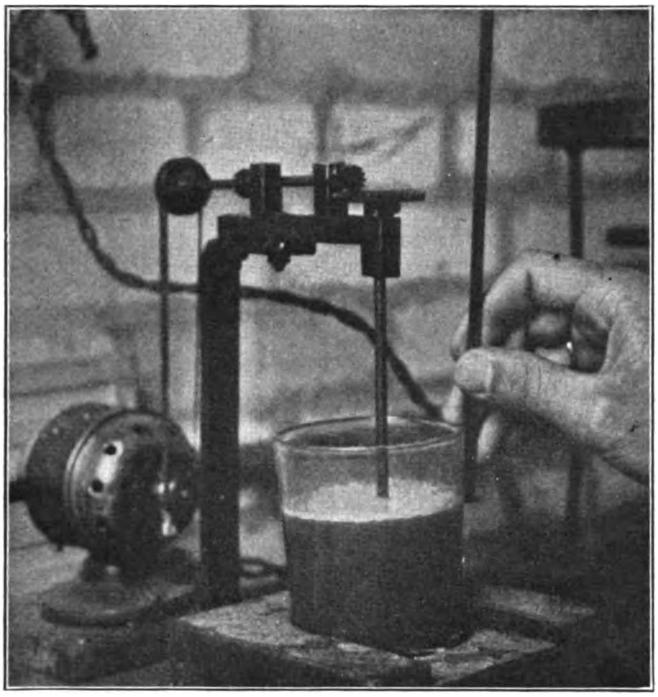


FIG. 5. FOAMING TEST FOR ANIMAL GLUES

Future activities in glues will embrace studies of glue and plywood manufacture, with reference to particular uses in various industries, improvements in quality and lowering costs of water-resistant glues, development of wide industrial use of waterproof glues, adaptation to furniture and vehicle manufacture, and assistance to makers of glued products in their special problems.

An article on "Water-Resistant Glues" by F. L. Browne of the laboratory was published in CHEMICAL & METALLURGICAL ENGINEERING, Aug. 1, 1919, in which the work was covered in considerable detail. The glues are mixed in an ordinary 3-speed dough mixer as described, and are tested in several ways. The standard test for tendency of glue to foam is shown in Fig. 5, the glue being stirred mechanically in a glass of standard size. The amount of foam formed is measured after a given time, and also the time consumed in subsiding is noted. Glue which foams badly may give unsatisfactory joints.

After the glue is applied and set in a plywood specimen, test of shearing strength of glued joints is made in the specially adapted Riehle cement briquet testing machine as shown in Fig. 6. The jaws were made in the laboratory shops. The strength of a glued joint depends not only on the chemical and physical qualities of the glue but also on the pressure exerted in the veneer press when the joint is setting. Either an excess or a lack of pressure weakens the joint. Standard formulæ have been worked out for this feature.

The data available from experiments completed cover a wide range of valuable information. Specifications have been made for glues purchased by the Army and Navy Departments, together with standard analyses. Moisture-proof coatings have also been developed.

Future research on plywood will include shrinkage factors for plywood of different species, accurate information as to strength and design of nail, screw and other fastenings for plywood, studies of warping and effect of vibration on plywood, effects of high temperatures on strength, absorption of moisture under varying humidity and effect on strength, and study of special adaptations in the industry.

PRESERVING WOOD

Losses due to decay of timber used in construction, poles, posts, piling, ties, etc., reach a high figure annually. Considerable work has been done to prevent this. Fig. 7 shows the equipment used in the laboratory for the pressure treatment of wood for both preservation against decay and fire-resistant compounds.

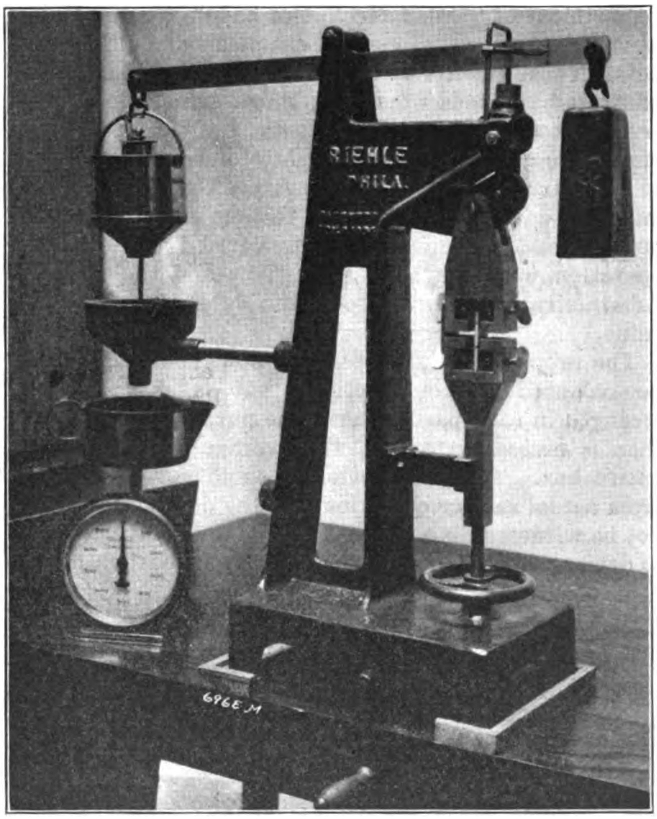


FIG. 6. RIEHLE MACHINE FOR TESTING GLUED JOINTS

The new work in this section will involve a study of preservatives to improve those now in use; new preservatives for salt water piling; improvements in preservative manufacture; determinations of wood penetration by preservatives to obtain better methods of treatment; an investigation of the fundamental prin-

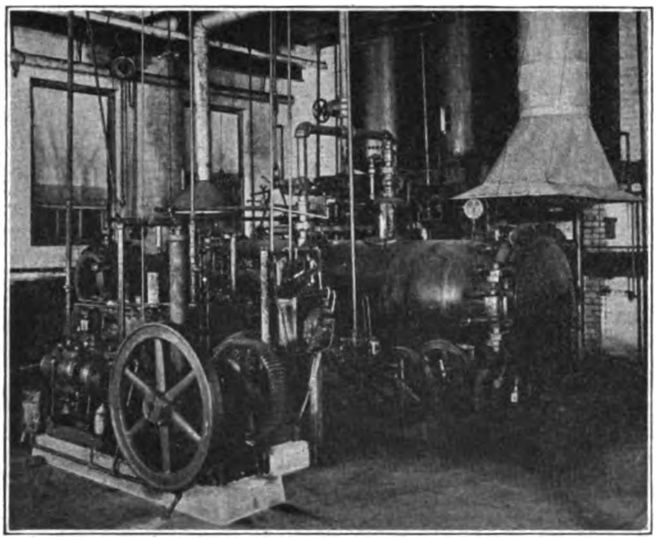


FIG. 7. WOOD IMPREGNATING RETORTS

ciples of decay and of the causes of deterioration of wood in buildings; and studies in fire protection both by changes in construction and fire-retardant compounds.

PACKING CONTAINERS

While the work of this section does not depend on the chemical laboratory for its results, nevertheless the Department of Timber Mechanics has discovered things of vital interest to shippers of chemicals and allied products. These results of box laboratory tests have demonstrated methods of saving large sums annually in freight, damage to goods en route, and conservation of lumber, to all shippers using crates or boxes. Previous to the starting of tests for the Army Ordnance Department no adequate method of testing a container had been devised. The work is being carried on in close co-operation with the box associations and the Railroad Administration in order to obtain data of the greatest value.

The properly designed packing box should first of all be balanced in construction, that is, have enough strength in each part to serve the purpose and no more than is necessary to equal the average strength of the entire box. The data obviously could not be collected from actual service conditions, as the destruction would not be witnessed in sufficient detail, so it was necessary to devise methods of test which would approximate service conditions and combine practical experience in box design with these tests.

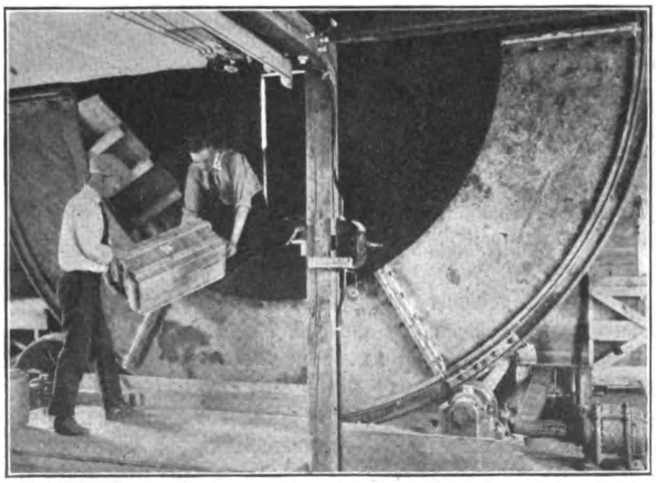


FIG. 8. LARGE BOX TESTING MACHINE

The compression-along-the-edge test is a steady and constantly increasing pressure (measured in pounds) applied along any edge with an opposite edge diagonally through the box in direct line with the pressure exerted. The cornerwise test is applied through diagonally opposite corners in the same manner. These two tests measure the resistance of a box to external pressure, but are insufficient to determine weaknesses and balanced construction. In comparing one box with another the drop test is of value. This consists of dropping a box on one corner from a specified height when loaded with contents. All these tests, however, are very much limited.

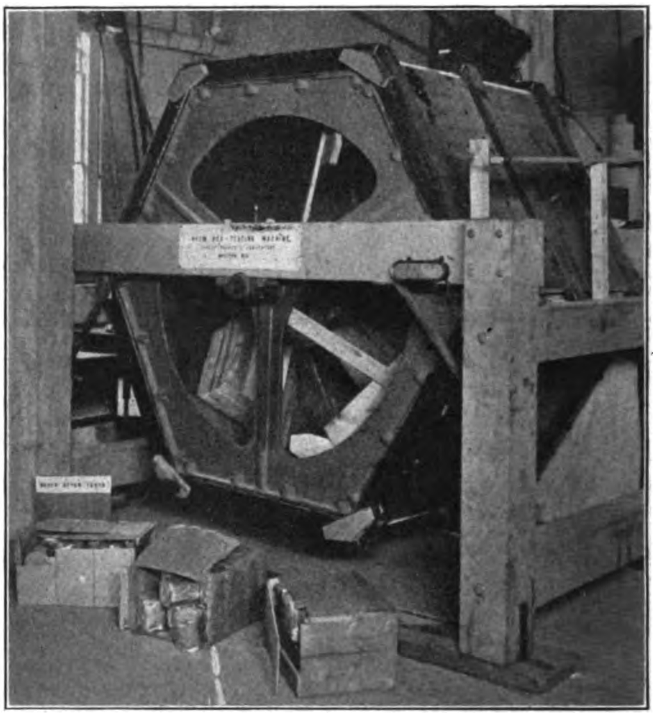


FIG. 9. SMALL BOX TESTING MACHINE

The new method consists of placing the box with contents in a hexagonal drum and slowly revolving the drum until the box is broken. Within this drum a regular cycle of drops of the box is arranged so it falls upon sides, top, bottom, ends, edges, corners and flatwise upon steel studs similar to corners of another box. This gives all the conditions of actual service except heavy pressure received in lower tiers of a pile. This is determined by the compression-on-edge test hitherto mentioned.

During the time the box is revolving in the drum each weak feature may be noted as it develops. Nails may pull out, material may split, and the observer, by repeated experiments, will eventually arrive at a box that is equally strong in every feature. Such defects in the wood as affect the proper efficiency of the container must be eliminated, but others not harmful to the balancing of strength should be allowed to remain, to keep down the cost of manufacturing.

Fig. 8 shows a part of the large machine used. It is about 18 ft. in diameter, with a hexagonal interior. The operator views the interior from the switch shown on the post or from the platform shown overhead. Fig. 9 shows the smaller machine in operation. The factory of every box-maker should contain one of these machines, for this method of "proof of the package" overshadows all the crude tests heretofore employed.

It discovers the size, quality and shape of lumber needed. It proves the kind, size and spacing of nails, the quality, size and location of metal strapping, the type of handle best employed, and all the special features required for the article to be packed.

The majority of the containers tested have been proved 15 to 20 per cent too heavy and occupied a like amount of excess space. Fig. 10 illustrates a crate designed to supersede a heavy box and employing the three-way corner construction. For foreign shipment of ordnance material the redesign of a box to carry thirty 1-lb. cans of saddle soap saved 43 per cent in cargo space. A redesigned cannon powder box carrying 140 lb. of powder saved 14 per cent space. Twenty-eight per cent of space was saved on a box for two Browning automatic machine guns, and 33 per cent on one for ten rifles. Official reports from France show that the broken package loss was only 15 per cent of that formerly occurring, which compares favorably with domestic shipments.

The future field for container research at the laboratory is at once seen to be large. The lines laid down for new work call for a determination of the best methods of box and crate construction; study of fiber and corrugated container design; design of barrels and baskets; finding the relation between weight of contents and thickness of material; preparation of specifications for domestic and export boxes; application of various types of strapping; study of holding power of nails; designs to use up short lengths of lumber; and a comprehensive study of records of loss and damage to shipping containers and methods of overcoming present losses.

Other work in timber mechanics has been extensive operations in airplane design. One feature of interest is the bending of heavy stock for artillery wheels as shown in Fig. 11. Many machines located throughout the laboratory are used for mechanical tests. Built-up sections of airplane beams, struts, ribs and operating parts are in the course of construction. These pieces show some valuable examples of wood fabrication for general application, and structural designers in the chemical industries may study them with profit.

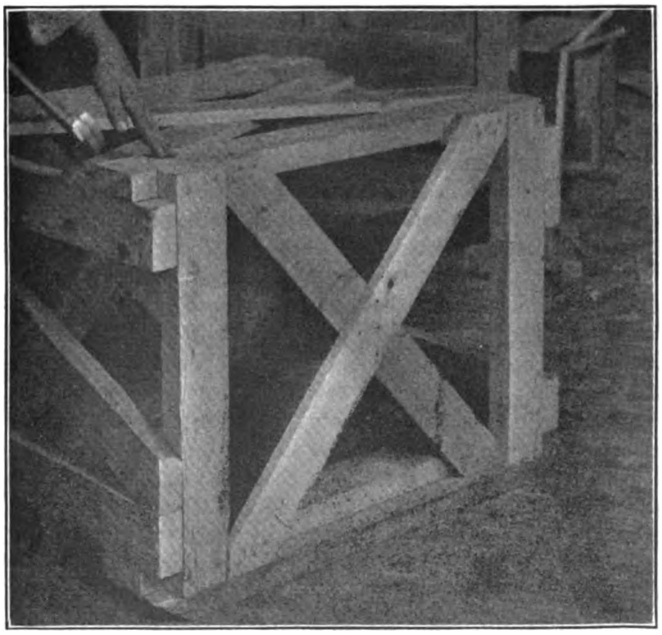


FIG. 10. ECONOMICALLY DESIGNED CRATE

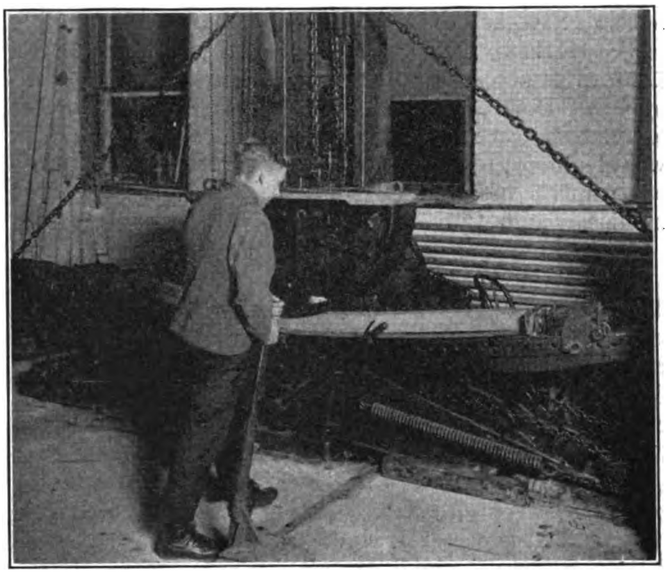


FIG. 11. BENDING WHEEL STOCK

Even a brief view of the operations is an education in mechanical design involving the use of timbers. Exhaustive tests are conducted on plywood and glued joints as well as those of specific articles of manufacture. Information furnished by this department is of great value to engineers, architects and manufacturers.

TIMBER PHYSICS

The dry kiln section renders service to all industries through the improvement in mechanical resistance of kiln-dried wood as compared to green timber. The majority of kilns in use are patterned after the Forest Products Laboratory kiln. It is hoped that the consumers of wood will ultimately see the advantage of using a kiln-dried product for all purposes.

The kiln consists of a brick-walled rectangular structure, heated within by steam coils. In addition to the steam piping a series of water sprays, located along the sides, furnish an air draught throughout the interior, at the same time giving the proper humidity to the atmosphere. The control of both temperature and humidity is entirely automatic.

The future work on drying will involve a continuation of studies on the effect of drying on additional species; requirements for the greatest strength and reduction in drying time; extension of exact information concerning the proper methods of certain refractory species like swamp oaks, the value of which is limited by seasoning difficulties; reduction of working formulæ to simplest terms when dealing with raw wood; and the making more accessible to manufacturers of lumber, vehicles, aircraft, freight cars, furniture, and interior finish, the basic data that have been evolved.

Additional work on kiln design proper will embrace the determination of types best suited to different kinds of work; perfection of kilns capable of accurate control at least cost; extension of basic information on improvement of commercial kilns now in use; investigation of various types now on the market; and supplying data to the industry for installation of better kilns.

The division on Derived Products is of the greatest interest to those who think in ways chemical, and while not so active as others at the present time, due mainly to the markets, it will nevertheless entertain CHEMICAL & METALLURGICAL ENGINEERING readers with its possibilities. Derived products, as in many other branches of the chemical industry, can be made from parts which would otherwise be wasted, a fact truly delightful to contemplate in these days when so many savings are made through the aptly called by-products.

Complete apparatus is installed for study in connection with wood distillation. Hardwoods previously thought unfit have been found available, causing the installation of new plants throughout the country. A method of controlling temperature of distillation has been developed which increases the production of calcium acetate 8 to 12 per cent and of wood alcohol 5 to 10 per cent. Tar still control has been improved, effect of wood moisture has been studied and new tar products for high-grade flotation oils have been discovered. The pine oils have become standards in the concentration of sulphide ores.

The cup and gutter system of turpentine orcharding developed by research is an example of the improvement in production of naval stores. Acetic and acetone work for airplane dope, gas mask charcoal from wood, carbon monoxide absorbent for gas masks, and the production of tear gases, poison gases and munition chemicals have all contributed to the utilization of wood wastes during the war. An oil-jacketed still for operation under constant temperature is used largely in distillation tests.

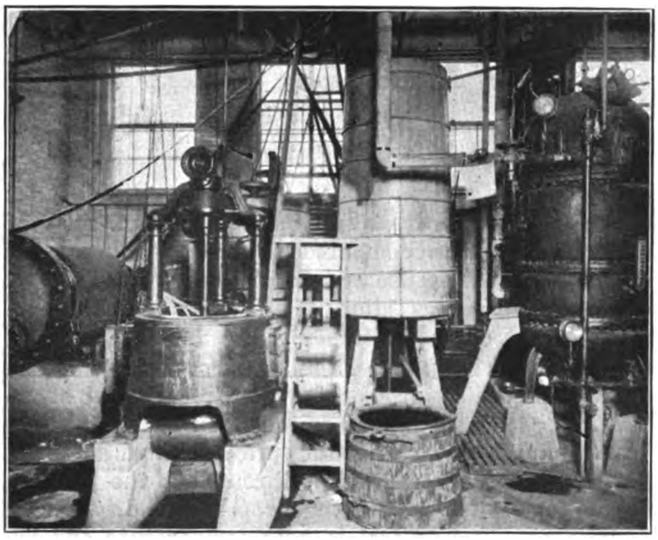


FIG. 12. ETHYL ALCOHOL FROM WOOD AND SULPHITE LIQUOR

In spite of the fact that we no longer are permitted to absorb ethyl alcohol directly, it nevertheless has an increasing use in pharmaceutical and cosmetic preparations. The laboratory has installed a complete plant for the production of ethyl alcohol from wood and sulphite waste liquors, shown in Fig. 12. The wood cellulose is converted into fermentable sugars by treatment with acid.

Other products derived from the forest growths are tannins, [illegible]al oils from bark and leaves and wood producer gas. Chemical derivatives from cellulose are also susceptible to development. A gum which is in demand by manufacturers of perfumes, tobacco, adhesives and drugs is produced from the red gum tree of the Southern States, though few owners realize its commercial value. Cinnamic acid and cinnamic alcohol are two of its valuable components.

Future investigations are contemplated in production efficiency and uses of turpentine, rosin, grain alcohol, acetic acid and charcoal; studies will be made to develop practical processes of value concerned with comparative yields of wood, increasing yields of valuable products and improved methods of refining products; classification of methods applied to wood species and quality, and value of products will be sought; the production and new uses of tar oils will be developed.

ADDITIONAL FUTURE RESEARCH

Although the large amount of effort put forth under high pressure during the period just past has given a wonderful impetus to forest products investigations as well as operations in the field on a commercial scale, the interest should be maintained. An extensive program of work is planned in addition to that covered here.

Industrial strength requirements have been demonstrated through present limited knowledge to be important. Determinations of the fundamental laws governing the strength of wooden columns, of the strengths of different wood species for use in telephone poles, etc., of definite factors of safety for beams under continuous loads, of efficiency of joints and fastenings in wooden structures, and conditions where low-grade woods may be used are all of commercial interest. Data must be obtained on use of wood for rebuilding railway cars, and also comparative data on strengths of commercial woods.

General lumber study will be developed to obtain data for cost accounting and timber appraisal, to obtain information on woods of the United States suitable for export, to determine new uses and markets for lumber as made possible through the development of plywood, built-up construction, etc., and to solve economic problems of lumber supply and distribution of finished products. The field work calls for liaison with lumber manufacturers, veneer and panel makers, vehicle and implement manufacturers, box makers, shippers, pulp and paper industry, turpentine, rosin and glue producers, dairymen, leather and tanning industries, railroads, engineers, architects and technical professions, fire underwriters, chemical industries, and others dependent on wood products.

PRACTICAL RESULTS OF THE FOREST PRODUCTS LABORATORY WORK

The years occupied in research by the Forest Service have borne fruit in the production of a large amount of data of general service to many industries and individuals, and copies of results may be had for the asking. The range of effort is so wide and the ramifications of the work so far reaching that it has been possible to mention only a few features in this article, with the hope of arousing the interest of those who may not be familiar with the more active phases, thereby bringing them in touch with the laboratory to the ultimate benefit of the industry.

The net gain in wealth to the nation through the activities of the Forest Products Laboratory is so great that adequate funds from general taxation should be always available for its financial support.

We are indebted to Mr. Rolf Thelen, acting director, for information making possible the preparation of this article.

Resistance of Absorption Tower Packing to Gas Flow*

By Fred C. Zeisberg

THE past few years have seen an enormous increase in the manufacture of various types of tower packing, and several patents have been taken out on designs developed by various inventors and manufacturers of chemical pottery. Acid manufacturers have been quick to recognize the advantages possessed by these manufactured packings, and have largely replaced the pumice, quartz or coke formerly used, with rings, blocks, and other shapes. While an improvement in absorption has nearly always accompanied the adoption of one of these modern packing materials, no numerical method of expressing this advantage has been available except the figures on surface and free space, quoted by the manufacturer of the packing, and these are frequently erroneous.

For this reason the E. I. duPont de Nemours & Co. undertook a study of various types of tower packing, with the purpose of checking up definitely the surface and free space figures not only of the artificial packings, but also of quartz and coke, and more important still, to investigate the resistance to gas flow offered by the various types of packing in common use. In large absorption systems the resistance is an important consideration, since if improperly designed, the system will require excessive pressures to bring about the necessary gas flow. It was hoped that the data obtained would stimulate packing manufacturers to produce newer and still better types of packing.

The projected study was mentioned to Mr. Hood, of the B. Mifflin Hood Brick Co., and he very kindly offered to donate such of his products as we might wish to test. His offer was accepted and the following packing material was furnished by him: 3 x 3 in. corrugated diaphragm rings, 3 x 3 in. corrugated spiral rings, 6 x 6 in. corrugated spiral rings, 6 in. Hechenbleikner blocks and 1½ x 4 x 8 in. chemical ware tile. The General Ceramics Co. also loaned us a supply of 1-in. Raschig rings.

Figures for the surface of the packing materials were calculated from measurements, and are expressed as "square feet per cubic foot." Since many of the British journals express this figure as "square yards per cubic yard" and the French and German journals as "square meters per cubic meter," it may be desirable to point out here that all of these values are of a different magnitude. One square foot per cubic foot is equivalent to 3 square yards per cubic yard or 3.28 square meters per cubic meter. With quartz and coke, of course, the measurements are approximate only, and consequently surface figures for these materials do not possess the accuracy of those for the manufactured packings. It might be well, also, to point out that in the case of the manufactured corrugated packings the assumption was made that the corrugations did not add anything to the surface, which is not strictly true.

Frictional Resistance to Gas Flow

The free space of a packing is the intersticial space. It is the space through which the gas must pass and is expressed as a percentage. Thus, a free space of 50 per cent means that in 100 cu.ft. of packing material 50 cu.ft. of gas passages exist. The free space herein reported was obtained by taking into consideration the number of pieces of packing required to fill a known volume, together with the average weight per piece and the apparent specific gravity of the packing material, or by actually weighing the amount of packing material whose apparent specific gravity was known which was required to fill a known volume. The free space naturally varies with the type of packing and with the manner of disposing it in the tower.

The resistance offered by a tower packing to gas flow is of course dependent upon both the free space and the surface exposed, but just what effect each might have it is impossible to predict. For this reason air was actually blown through a variety of packings under various conditions and the resistance was actually measured.

Experimental equipment consisted of a Wilbraham Green positive-pressure blower connected with a series of chemical ware absorption towers 30 in. in diameter and approximately 15 ft. high. The air passed into the bottom of each tower in succession, being carried from the top of one tower to the bottom of the tower

TABLE I—CHARACTERISTICS OF VARIOUS TOWER PACKINGS

Packing	$\times 10^{-7}$									Per cent free space	Surface sq.ft. per cu.ft.	Weight lb. per cu.ft.	No. units per cu.ft.
	f_{dy}	f_{dw}	f_{dc}	f_{sy}	f_{sw}	f_{sc}	f_{py}	f_{pw}	f_{pc}				
Quartz, 6 in.	58	60	60	..	..	..	..	..	..	44	6.3	89	..
Quartz, 3 in.	101	110	139	..	..	..	..	..	..	46	12.7	86	..
Quartz, 2 in.	384	396	433	..	..	..	..	..	..	46	18.7	88	..
Quartz, ½ in. to 1 in.	672	865	1095	..	..	..	..	..	..	47	50.3	88	..
Coke, 3 in.	76	81	94	..	..	..	..	..	..	58	12.7	29	..
Coke, ½ in. to 1½ in.	219	380*	..	..	..	..	..	..	..	..	..	..	..
4 in. x 3 in. smooth diaphragm rings	51	56	63	25	34	38	..	32	34	64 (1)	20.0	50	27
										51 (2)	27.0	66	36
										51 (3)	27.0	66	36
3 in. x 3 in. corrugated diaphragm rings	51	56	63	31	42	58	26	28	28	65 (1)	24.0	48	53
										57 (2)	30.0	61	67
										55 (3)	31.0	63	70
3 in. x 3 in. corrugated spiral rings	45	54	63	54	54	61	..	..	..	72 (1)	22.0	40	48
										64 (2)	29.0	53	68
6 in. x 6 in. corrugated spiral rings	..	..	..	38	47	50	24	33	35	58 (2)	15.0	53	8
										58 (3)	15.0	53	8
6 in. corrugated Hechenbleikner blocks	16	36	36	35	38	38	26		28	72 (1)	10.7	[illegible]	4.2
										62 (2)	[illegible]	[illegible]	5.6
										62 (3)	[illegible]	[illegible]	5.6
1 in. Raschig rings	345	345	345	..	..	..	..	..	..	73	58.0	[illegible]	1350
Tile on edge, unstaggered	..	..	..	..	..	..	31	31	43	59	10.5	62	16
Tile on edge, staggered	..	..	..	..	..	..	18	24	31	75	6.4	35	9.5
Tile on edge, staggered	..	..	..	..	..	..	31	33	35	55	11.6	68	17.5
Tile on edge, staggered	..	..	..	..	..	..	43	43	74	45	14.0	81	21
Tile staggered, alternate rows flat	..	..	..	..	..	..	41	48	57	49	13.2	77	20

* Wet with 92 per cent sulphuric acid instead of water. (1) dumped. (2) stacked. (3) packed.

---

*Read at the Savannah meeting of the American Institute of Chemical Engineers, Dec. 3-6, 1919.

following by an 8-in. pipe. A valved side connection in the pipe to the first tower was provided, so that the amount of air passing into the tower could be regulated by spilling the excess to the atmosphere. The air passing into the tower was measured with a glass Pitot tube of the American Blower Co. type, while differential manometers, protected from velocity pressure effects, were provided at the bottom and top of each tower to measure the static pressures at those points. A carefully measured height of the packing to be tested was supported on a checkered brick pier in the bottom of the tower. The resistance offered by this pier to an air flow much larger than is ever likely to be met in practice was actually determined to be negligible. In some cases a series of measurements was made simultaneously in several towers, but since the results thus determined were found to be in good agreement the later tests were run on only one tower.

DERIVATION OF CONSTANTS

Since the constants which are shown in Table I, together with other characteristics of various types of packing, will be unintelligible without explanation, it is desirable at this point to give some attention to the theoretical considerations involved.

Assuming that the general law of the flow of fluids holds in this case (this was experimentally demonstrated to be true), the frictional resistance is proportional to the square of the velocity of flow. This resistance may be expressed as the pressure necessary to produce the given flow.

Let s = linear velocity in ft. per. min.
p = pressure in inches of water
k = a fractional constant
a = area of cross section of packing in sq.ft.
h = height of packing in ft.
v = volume of air passing in cu.ft. per min.

$$\text{Then } p = \frac{ks^2}{v} \tag{1}$$

$$\text{and } s = a \tag{2}$$

$$\text{Therefore } p = \frac{kv^2}{a^2} \tag{3}$$

Since the resistance or the pressure varies directly as the height of the packing we may write

$$p = \frac{khv^2}{a^2} \tag{4}$$

However, k is a general constant, varying in value with the type of packing. We have therefore designated f as the frictional coefficient of 1 sq.ft. of packing 1 ft. high, and may write equation (4) as

$$p = \frac{fhv^2}{a^2} \tag{5}$$

f of course differs for each style of packing, with its method of disposal in the tower and with the amount of liquid circulating in the tower. In order to make f more descriptive, subscripts have been added, as follows:

f_d = packing dumped into tower
f_s = packing stacked, i. e., arranged regularly in layers, but with no attempt to have pieces in one layer in any way related to those in adjacent layers.
f_p = packing packed, i. e., arranged regularly in layers, with the axes of pieces in adjacent layers coinciding.
f_y = packing dry.
f_w = packing wet with water, but drained as completely as possible.
f_c = packing with water circulating over it at a rate of 11 lb. per sq.ft. cross sectional area per min.

It is, of course, evident that we may have, for example, f_{dy} = packing dumped and dry, and that quartz or coke can give values only for f_d and not for f_p or f_s.

The frictional coefficient was then determined for various packings under various conditions, by measuring the pressure drop through a tower filled to a known height with the packing and calculating this value to the standard condition of a 1-ft. cube. These values of f, together with other characteristic data, are given in tabular form in Table I. It should be emphasized that the frictional coefficient values are not accurate to more than two significant figures, and in some cases the second figure is in some doubt.

VARIATION OF RESISTANCE WITH PACKING SIZES

These figures speak for themselves; nevertheless, a few of the more obvious facts will be pointed out. For instance, it is interesting to note how rapidly the resistance to gas flow increases with decrease in size of material (see quartz). That this resistance is not entirely a function of the surface exposed by the packing is indicated by the fact that as the size decreases the resistance increases first less rapidly than the surface and then considerably more rapidly. Another interesting fact is the increase in resistance, with the smaller packings, due to a mere wetting of the packing. Often the difference in resistance between a dry and a wet packing is greater than the difference between a merely wet packing and the same packing with considerable water circulating over it.

Perhaps the most noticeable thing brought out by Table I is the fact that for a given size of packing the manufactured packings give much more surface and greater free space and interpose much less resistance in the absorption system than quartz, coke or packings of that kind. Many other points will be obvious to the reader.

PROBLEM AND SOLUTION BY USE OF CONSTANTS

An example of the application of the resistance constants may not be amiss. Suppose it is desired to find out what pressure will be necessary to force 250 cu.ft. of air per minute through an absorption system composed of 5 towers 2 ft. in diameter and filled 10 ft. deep with absorption material, when 3-in. quartz is used or when 3-in. spiral rings, stacked, are used, the rate of water circulation being 5 lb. per sq.ft. cross sectional area per minute.

The cross sectional area of the packing is $\frac{\pi 2^2}{4} = 3.14$ sq.ft. The total height is $5 \times 10 = 50$ ft. For quartz f_{dy} would be about $120 \times 10^{-7} = 0.000012$, and for spiral rings about $58 \times 10^{-7} = 0.0000058$ (since the rate of circulation for f_c in Table I was 11 lb. per sq.ft. per min., values are assumed about halfway between f_w and f_c).

We have seen from equation (5) that the pressure is $p = \frac{fhv^2}{a^2}$, or, substituting numerical values for f, h, v, d,

$$p = \frac{0.000012 \times 50 \times (250)^2}{(3.14)^2} = \frac{0.000012 \times 50 \times 62500}{9.88} = \frac{37.5}{9.88} = 3.8$$ in. water for quartz. For spiral rings the pressure would be $3.8 \times \frac{0.0000059}{0.000012} = 1.8$ in.

In closing this paper the writer wishes, first, to thank E. I. duPont de Nemours & Co. for permission to publish these results, and, second, to acknowledge the great assistance of Dr. Guy B. Taylor in obtaining the figures, the actual carrying on of the experimental work being in his hands.

Use of Rosin in Paint and Varnish*

By Maximilian Toch

As far back as any man in the paint and varnish industry can remember, rosin has not only been despised, but its general use has been discouraged by paint chemists, and endless numbers of tests have been devised so that as a paint and varnish material its use has been discouraged. In addition to that, manufacturers have always been more or less ashamed to acknowledge that they have used it; and, so far as I am personally concerned, I have never been a believer in it, excepting for the manufacture of resinates as driers, because up to within a few years ago no rosin varnish or paint oil containing rosin had been made which had much merit. Up to 1914 there was hardly a specification that I know of that did not read similar to the following one which I quote.

CABINET RUBBING VARNISH

> *Composition*—To be made exclusively from the best grade of hard varnish resins, pure linseed oil, pure spirits of turpentine, and lead manganese driers, and be free from all adulterants or other foreign materials.

PAINT DRIER

> *Composition*—To be composed of lead, manganese, or cobalt, or a mixture of any of these elements, combined with pure linseed oil and hydrocarbon solvent, and to be free from adulterants, sediment, and suspended matter. Resins other than rosin may also be used at the option of the manufacturer.

JAPAN DRIER

> To be made of varnish gums, linseed oil, turpentine and lead and manganese driers. Common rosin, benzine and similar adulterants must be absent.

SPAR VARNISH

> *Composition and Quality*—Spar varnish shall be made exclusively from the best grade of hard varnish resins, pure linseed oil, pure spirits of turpentine and lead-manganese or cobalt driers, and shall be free from all adulterants or other foreign materials.

It is not my intention to go deeply into the chemistry of rosin, because the material is well known and has specific characteristics. Suffice it to say that rosin is obtained from the sap of certain species of pine trees. This sap is collected by scarifying the tree and collecting the sap, which solidifies under the name of "gum thus." When this "gum thus," which is a yellow, viscous, semi-hard and waxy looking material, is distilled, it yields turpentine by condensation and rosin remains behind.

Rosin is a brittle, soft resin, which ranges in color from a pale yellow glass-like looking substance to a very dark brown, almost black solid. It melts very readily and is practically fluid at the temperature of boiling water. Under ordinary circumstances, when converted into a paint oil or into a varnish, it turns white and becomes friable when subjected to even slight moisture and rubs off very readily when even slight friction is applied. It is so highly acid that lead and zinc, or other basic pigments, cannot be mixed with it, for it forms resinates so rapidly that the resulting material "livers," or becomes semi-solid or gelatinous before it can be entirely applied or consumed. It does not stand water, and when used as a furniture varnish it becomes soft and sticky on a rainy day; and, all in all, it has been regarded as a totally unfit material for paint or varnish purposes. Yet, the great reason for its use has been that there is nothing like it so low in price, and consequently it was a ready adulterant for the higher priced and better resins.

A TYPICAL CASE

Speaking again of the specifications which prohibited its use, I recall a case some years ago where a manufacturer furnished under a Government specification a large quantity of spar varnish for boat use, and the specification read that the varnish was to be composed of fossil or semi-fossil resins reduced with linseed oil and a proper solvent and drier. The varnish was delivered and was rejected, because it gave the Liebermann-Storch color reaction for rosin.

The manufacturer contended that he did not put rosin in the varnish as an adulterant, and the Government claimed that the specifications had been violated; and, in order to settle this matter and prevent a law-suit, the Government selected me as an arbitrator and the manufacturer did the same. On investigation, I found that a very small percentage of rosin had been used to "grease the kettle" in order to prevent the discoloration of the fossil resin by melting, and I therefore decided in favor of the manufacturer. But this, and many other examples that I could cite, indicate that rosin as a paint material, and more particularly as a varnish compound, has been largely discouraged for the reasons that I have cited:

First.—Because it is no good.

Second.—Its price has been so low that it was used as an adulterant or a cheapening material.

HISTORY OF CHINA WOOD OIL

But the advent of china wood oil has brought about a change, and I am unafraid to admit that, while I despised and discouraged the use of it in my own factory, I am now a firm believer in it; and, until something better can be discovered, rosin has at last come into its own.

Let us remember that fifteen years ago china wood oil was condemned because its physical characteristics were compared with linseed oil, which shows us that it is a mistake to take a new material and judge it by an older one. Raw linseed oil, as everyone knows, dries with the aid of a drier, and when suitably mixed with the proper pigments forms a film which lasts anywhere from three to eight years, even under extreme exposure.

Raw china wood oil, on the other hand, no matter what it is mixed with, dries with an opaque, brittle, crystalline film, which is neither flesh nor fowl. It polymerizes or solidifies when heated for twenty minutes to 420 deg. F. (216 deg. C.). It is difficult to manipulate and in unskilled hands it is a failure. But when 4 lb. of china wood oil is heated with 1 lb. of rosin that has been partially or wholly converted into a resinate of lead or similar compound, the heat can be carried up to 600 deg. F. (315 deg. C.) without danger of the polymerization of the oil, and a varnish is obtained which, while fairly high in acid number, possesses more remarkable qualities than the best kauri linseed oil varnish ever made. This sounds strange, but it is true.

---

*Read before the American Institute of Chemical Engineers, Dec. 5, 1919, Savannah, Ga.

Of course, to those skilled in the art it is known that this resultant fusion of 5 lb. just mentioned must be diluted with equal quantities of turpentine or turpentine substitute, and the film so produced will not turn white after it has been permitted to dry thoroughly, even though the test sample is placed in water for weeks. When I made my first experiments along these lines I did not use the material as a varnish, but I used it as a paint oil. Of course, lead and zinc could not be used as bases, because chemical union would take place, and the compound, which I called a tungo resinate of lead or zinc, was formed, which was a viscous, ropy, gelatinous material, physically unfit for making paint ready for use. But, if the proper pigments were selected, such as graphite lithopone, red oxide and blanc fixe, a paint could be made which remained in suspension for a long time.

As many know, I do not rely upon laboratory experiments for the finding of my conclusions; but in 1915 and 1916 I made several hundred gallons of various colored paints, omitting linseed oil entirely as a vehicle, and substituting for it a varnish made from rosin and china wood oil, and these paints I applied to wooden structures on the Atlantic coast which were from 100 to 500 yd. distant from low tide and subject, therefore, to the heavy sea fogs of that locality. In comparison with these tests there were a number of smaller buildings painted with various mixtures of lead and zinc and linseed oil, and the conclusions arrived at were that the gloss and hardness of the resulting film, after three years, was as good for the rosin:china wood oil mixture as for the linseed oil paint, with this exception—that the rosin:china wood oil paint left a better surface for repainting.

REVERSAL OF STATUS OF ROSIN

Rosin forms esters with certain alcohols like glycerine and phenol, in which the rosin acts as the base and the alcohol as the acid; so that, under certain circumstances, if we follow the experiments of Schall and use a silver-lined or aluminum kettle, we get a glyceride of rosin which is soluble in china wood oil at temperatures up to 600 deg. F. (315 deg. C.), and the resultant varnish has a very low acid number ranging between 7 and 15, which makes it more suitable for mixtures with lead and zinc. But, used alone, rosin esters produce waterproof varnishes which are so far superior to the linseed oil-fossil resin varnishes that the newer specifications of the Government not only permit their use, but encourage it. Specifications used by the Railway Commission and other branches of the Government service are quoted below:

RAILWAY FINISHING VARNISH

> It must be resistant to air, light and water. The manufacturer is given wide latitude in the selection of raw materials and processes of manufacture, so that he may produce a varnish of the highest quality. Preference will be given to rapid drying varnishes.

FLAT FINISH INTERIOR WALL PAINT

> The paint supplied must be ready for use for finish coat work. There shall be present not less than 65 or more than 70 per cent of pigment. The vehicle must be composed of treated oils and volatiles, or varnishes which produce a satisfactory washable flat finish.

DECK AND FLOOR PAINT

> The vehicle shall consist of linseed oil and sufficient waterproof varnish to give the paint a high gloss and resistance to abrasion and water. The varnish in the paint shall conform to the general specifications for varnish.

SPAR VARNISH FOR USE IN AIRPLANE CONSTRUCTION

> The manufacturer is given wide latitude in the selection of raw materials and processes of manufacture so that he may produce a varnish of the highest quality. Rapidity in dust-free drying and final hardening is essential.

It may interest the public to know that nearly all automobiles are varnished nowadays with varnishes of this type. There again, I have conducted a large series of experiments, having painted and varnished no less than twenty automobiles in the last four years with this particular type of varnish. I have the record of one particular automobile which, after one year of hard service in all kinds of weather, is still brilliant and glossy and does not need revarnishing. Rain, sleet or snow has no effect on a varnish of this type and does not produce the well-known bloom or bluish spots so familiar to those seen in linseed oil varnish.

Since the war the price of rosin has risen until it is today such a high-priced material that we will not frown down upon it on account of its low price.

ONCE DESPISED MATERIALS NOW PRECIOUS

Human nature is very peculiar with reference to the embrace of materials which once were despised and come under the category of that well-known stanza in Pope's Essay on Man—"We first abhor; then pity; then embrace." Everyone of us can remember when the metal platinum was only used in the laboratory because of its insolubility and high melting point. Its price when I was a student was about one-third that of gold, or even less. As the price rose and it became a really expensive material, two and a half times dearer than gold, it was fashionable to use it as a setting for diamonds, even though its color was leaden and the polish soon dimmed. Now that platinum is worth five times more than gold, it is idolized by the rich only, it would seem, on account of its price.

Turpentine has always been regarded as the ideal paint solvent, and specifications, tests and laws have been made to prevent the adulteration of turpentine with the petroleum products. Yet in 1911, the price of gasoline in Italy was twice that of turpentine. Furthermore, there was no tax on turpentine, but there was one on gasoline, and it was a criminal offense in Italy to adulterate gasoline with turpentine.

A hundred and fifty years ago, when a good slave was sold in the South, particularly along the coast, the deed usually recited that the slave must not be fed on terrapin, which, as you know, is a species of turtle that was once so abundant that it was even despised by the negroes as food. But when the terrapin became rare, and finally a small portion of it—hardly more than 100 grams—sold in restaurants for $3.50, only the elect few and the newly rich regarded it as fashionable to eat terrapin.

Five years ago rosin sold at about 2c. a lb., and today it has gone to 10c. a lb. Legitimate uses of rosin will raise its price so that who knows but some day it will be considered criminal to adulterate rosin with the fossil resins of the Orient?

Electric Furnace for Experimental Work*

BY F. A. J. FITZGERALD AND GRANT C. MOYER

IN OUR work we have found that for a variety of small-scale experiments the furnace which is shown in the drawings illustrating this note and which we use in the laboratory has been found by us convenient and satisfactory.

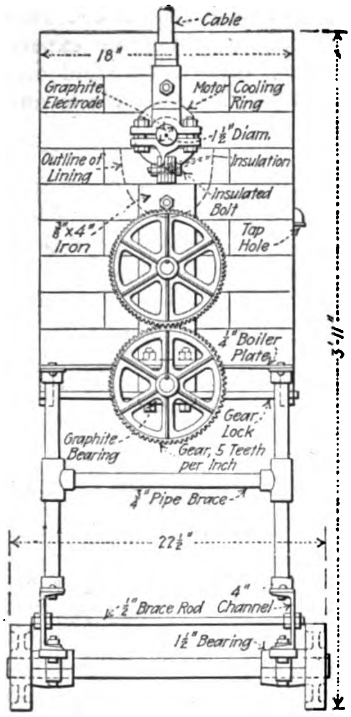

Cable
18"
Graphite Electrode
Motor Cooling Ring
1½" Diam.
Outline of Lining
Insulation
Insulated Bolt
⅜"x4" Iron
Tap Hole
3'-11"
¼" Boiler Plate
Gear Lock
Graphite Bearing
Gear, 5 Teeth per Inch
¾" Pipe Brace
22½"
½" Brace Rod
4" Channel
1½" Bearing

FIG. 1. END VIEW OF FURNACE

The furnace is mounted on a truck built of channel irons, a pipe framework and boiler plate. The electrode holders and their working mechanism are mounted on the boiler plate, and the furnace is built on this. The electrode holders are aluminum bronze castings and are moved to and fro by means of right- and left-handed screws respectively. The shaft of each screw terminates in a gear engaging with gears mounted on a shaft which passes under the boiler plate base and which has a hand wheel mounted at one end. By this hand wheel one worker can attend to the running of the furnace. The hand wheel shaft is in two parts connected with a coupling and near this is a small collar on the shaft. This arrangement is used to form what we call a "gear lock," which consists of an iron bar held between the collar and the coupling. This bar is hinged and can be dropped down so that the hand wheel shaft may be pushed longitudinally in its bearings sufficiently far to throw the gears out of mesh.

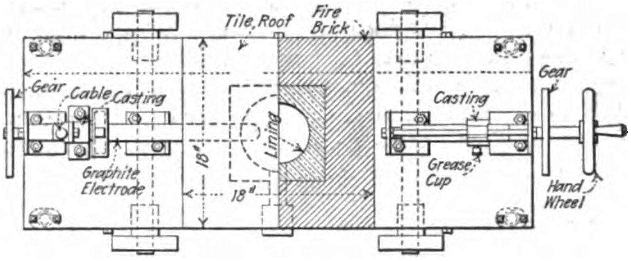

Tile Roof
Fire Brick
Gear
Cable
Casting
Graphite Electrode
18"
18"
Lining
Casting
Gear
Grease Cup
Hand Wheel

FIG. 3. PLAN OF A SECTION OF FURNACE

This allows the electrode holders to be separately adjusted when desired. The water-cooling rings are bronze castings and slide on the electrodes. They are hollow and open at the top so that they can be kept filled with water, thus cooling the electrodes. The rings should not be in the position shown in the drawing, but should be pushed up close to where the electrodes pass through the furnace walls.

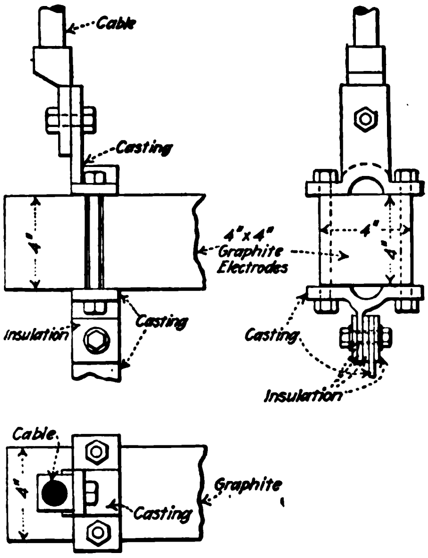

Cable
Casting
4"
4"x4" Graphite Electrodes
4"
Insulation
Casting
Casting
Insulation
Cable
4"
Graphite
Casting

FIG. 4. DETAILS OF ELECTRODE HOLDERS

As shown in the drawing, the furnace is built up so as to heat the charge in the crucible by radiation from the arc. In our work we generally use a current at 50 volts and 500 to 1000 amperes.

The apparatus can also be used for other kinds of furnaces; for example, for heating a crucible embedded in granular carbon. When used in this way convenient electrodes are 4 x 4 in. (10 x 10 cm.) graphitized carbons. Fig. 4, besides showing details of the electrode holder construction, shows modification for use with 4 x 4 in. carbons. The mobility of the electrodes permits of considerable variation in the resistance of the furnace while running with a granular carbon resistor.

The furnace also is convenient for heating the central portion of a horizontal tube embedded in a granular carbon resistor, and, of course,

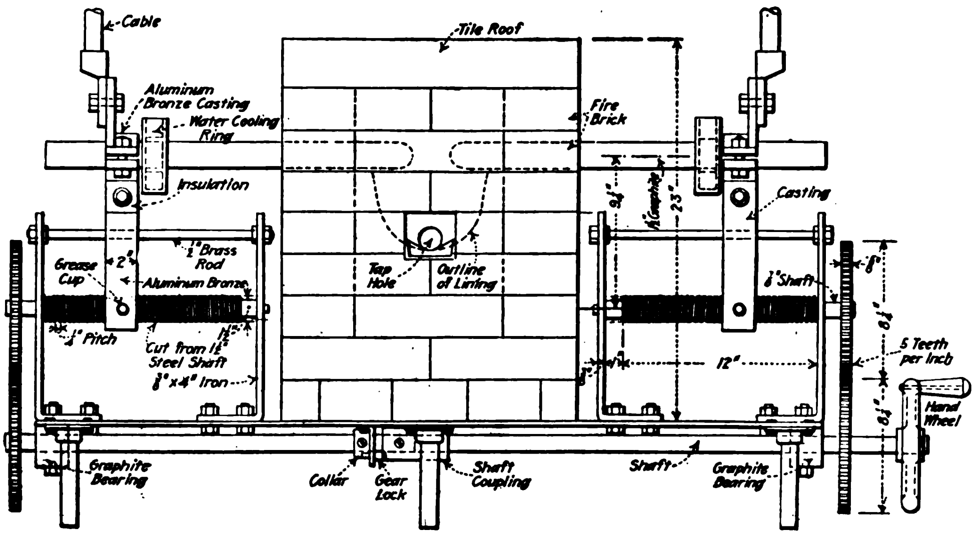

Cable
Tile Roof
Aluminum Bronze Casting
Water Cooling Ring
Fire Brick
Insulation
Casting
9¼"
4" Graphite
23"
½" Brass Rod
Grease Cup
2"
Aluminum Bronze
Tap Hole
Outline of Lining
⅞" Shaft
⅛"
8¼"
¼" Pitch
Cut from 1½" Steel Shaft
1½"
⅜"x4" Iron
12"
5 Teeth per Inch
8¼"
Hand Wheel
Graphite Bearing
Collar
Gear Lock
Shaft Coupling
Shaft
Graphite Bearing

FIG. 2. SIDE VIEW OF FURNACE

---

*Paper read at the meeting of the American Electrochemical Society in Chicago, Sept. 23-26, 1919.

it may also be used as a furnace in which the tube is heated by an arc on the outside, but in this case the 1½-in. (3.8-cm.) electrodes are used.

While there is nothing original in the general principles of the furnace, it is believed that the detail design may be found as useful by others as it has by us, on account of its being so cheap and easy to construct.

FitzGerald Laboratories,
Niagara Falls, N. Y.

Experience With a 91:9 Copper-Aluminum Alloy

By A. I. Krynitzky*

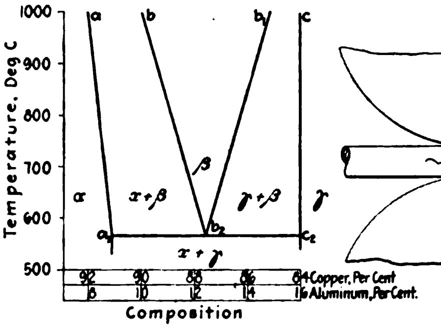
After many experiments in the foundry of the Time Fuse Plant in Petrograd, Russia, with different copper-aluminum alloys it was decided to use an alloy containing about 9 per cent of aluminum. It might be stated in advance that with 10 per cent aluminum or more it is very difficult to obtain a homogeneous alloy, particularly with a single melting. In most cases the fracture shows a liquation and also a coarse crystalline structure.

Referring to the equilibrium diagram, these alloys—9 to 10 per cent of aluminum—are very close to the point a_1 (see Fig. 1). We have to expect here the presence of homogeneous alpha solution in the case of annealed alloys containing 9 per cent or less of aluminum; and in the case of 10 per cent or more aluminum, secondary alpha crystals within the primary beta, and also alpha and gamma crystals within original grains of beta.

Concerning the process of casting, in the first place a well known fact was confirmed, that the temperature of the casting is of great importance. The alloy must be poured at a temperature very near its melting point, which in the absence of a pyrometer is difficult to get because of the formation of a thin film, which makes observation difficult. Chill casting is better than sand casting.

Purity of Raw Material Important

The purity of the raw material is, as usual, very important. This fact was confirmed in these experiments with four kinds of copper used: Mansfeld copper, Bare, Tamarack and a Chinese brand. While uniformly good results were obtained with the first three kinds of copper, the last one gave very bad results; it contained a relatively large amount of oxygen.



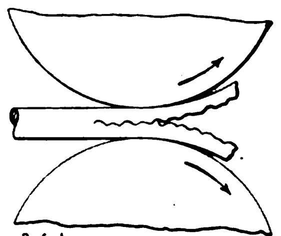


FIG. 1. PART OF EQUILIBRIUM DIAGRAM FOR COPPER-ALUMINUM ALLOYS, FROM G. H. GULLIVER. FIG. 2. SKETCH SHOWING NATURE OF BREAK IN SPLIT RODS

There was no opportunity to compare different kinds of aluminum, as only one kind was used: aluminum of Neuhausen, Switzerland. Analysis of the above-men-

TABLE I.

Per Cent of Aluminum in Alloy	Lot No.	Method of Casting	Final Annealing	Diameter of Cast Bars, Inches	Final Diameter of Finished Bars, Inches	Mechanical Properties on Tension					
						Yield Point		Ultimate Strength		Elongation for 72 Mm., Per Cent.	Reduction of Area $\frac{S-s}{S}$ Per Cent.
						Kg. per Sq. Cm.	Lb. per Sq. In.	Kg. per Sq. Cm.	Lb. per Sq. In.		
10	1	Chill cast	None	1.125	0.570	......	......	2,770	39,398	6.9	.....
10	2	Same	None	1.125	0.570	4,087	58,130	5,073	72,154	12,5	.....
10	3	Same	None	1.125	0.570	3,768	53,593	5,283	75,142	13.5	.....
10	4	Same	Was done	1.125	0.570	5,386	76,606	6,379	90,729	36.9	.....
9	5	Sand cast—dry sand	None	1.100	0.570	5,500	78,228	5,856	83,291	20.2	.....
9	6	Same	None	1.100	0.570	4,869	69,253	5,799	82,480	23.5	.....
9	7	Sand cast—green mold	None	1.100	0.570	......	......	3,183	45,272	3.8	.....
9	8	Sand cast—dry sand	None	1.100	0.570	4,096	58,258	6,175	87,827	25.2	.....
			Was done	1.100	0.570	4,010	57,035	6,366	90,544	30.1	.....
9	9	Same	None	1.100	0.570	5,131	72,978	5,870	83,489	24.4	.....
9	10	Same	None	1.100	0.570	5,054	71,884	5,870	83,489	33.3	.....
9	11	Same	None	1.100	0.570	5,092	72,424	5,730	81,498	35.8	.....
9	12	Same	None	1.100	0.570	4,678	66,536	5,462	77,686	31.7	.....
9	13	Same	None	1.100	0.570	4,073	57,931	5,366	76,321	46.7	.....
9	14	Same	None	1.100	0.570	4,456	63,378	5,563	79,124	43.8	.....
9	15	Same	None	1.500	0.750	......	......	5,283	75,141	21.8	.....
9	17	Same	None	1.500	0.750	3,819	54,318	5,391	76,677	41.1	.....
10	21	Sand cast—dry sand without mechanical work	None	1.600	1.600	4,583	65,184	5,131	72,978	14.0	.....
9	22	Chill cast	None	1.250	0.750	5,697	81,029	6,239	88,739	38.7	.....
9	23	Same	None	1.250	0.750	5,697	81,029	7,282	103,576	12.9	.....
9	24	Sand cast—dry sand: (a) Low forging	None	1.600	0.750	5,793	82,394	6,009	85,467	18.6	.....
		(b) Medium forging	None	1.600	0.750	6,332	90,061	6,421	91,326	20.4	.....
		(c) Great forging	None	1.600	0.750	......	......	6,810	96,860	21.2	.....
9	25	Chill cast	None	1.250	0.750	5,517	78,469	5,953	84,670	29.0	.....
9	26	Same	None	1.250	0.750	5,262	74,843	5,984	85,112	39.0	.....
9	27	Sand cast—dry sand	None	1.600	1.240	6,028	85,737	6,282	89,350	24.1	.....
9	28	Same	None	1.600	0.750	6,221	88,483	6,408	91,142	21.3	.....
9	29	Chill cast	None	1.250	0.750	4,349	61,857	5,598	79,622	39.3	.....
9	30	Chill cast	None	1.250	0.750	7,214	102,609	7,325	104,186	16.9	.....
9	31	Chill cast	None	1.250	0.750	7,670	109,096	7,767	110,473	13.7	.....
			Was done	1.250	0.750	3,647	51,871	6,149	87,458	32.1	.....
9	32	Same	None	1.250	0.680	7,129	101,392	7,312	104,001	14.7	.....
9	33	Same	None	1.250	0.680	6,684	95,068	7,079	100,686	17.6	25.6
9	34	Chill cast and quenched in cool water	None	1.250	1.250	2,896	41,190	4,233	60,206	16.3	24.1
		Chill cast and slow cooled	None	1.250	1.250	2,896	41,190	5,634	80,134	29.1	30.9
		Chill cast	None	1.250	0.680	5,730	81,499	6,989	99,406	29.2	38.1
		Chill cast	Was done	1.250	0.680	4,551	64,729	7,136	101,492	.....	31.5

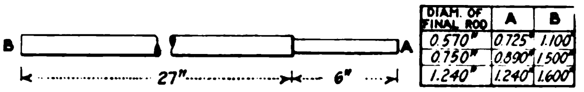
---

*Formerly chief inspector of time fuses for the Russian Government in the United States; now assistant physicist, Bureau of Standards, Washington, D. C.

tioned first three kinds of copper showed very close to 99.6 per cent copper. Analyses of the aluminum were very close to Al 98.81 per cent, Si 0.45 per cent, Fe 0.44 per cent.

All work was done under manufacturing conditions. The alloy was melted and cast in the ingots and then remelted (sometimes more than once) in crucibles, in an oil-fired furnace, a thin layer of charcoal being used to cover the charges to prevent oxidation. For stirring the melts graphite rods were used exclusively.

As before noted, the use of an alloy with 10 per cent or more aluminum is not recommended, since such an alloy requires too many precautions in its manufacture. From our experience it was found that in most cases the cast rods had many blow-holes and contained along the axis a material which showed up very definitely in cross-section as a gold band against the gray-white background of the alloy.



DIAM. OF FINAL ROD	A	B
0.570"	0.725"	1.100"
0.750"	0.890"	1.500"
1.240"	1.240"	1.600"

FIG. 3. SAND-CAST BARS

FRACTURE DURING ROLLING

High aluminum rods during cold rolling were easily split in two parts, the fracture very often showing almost regular teeth, as in Fig. 2. Also in case some good rods could not stand more or less severe cold rolling, they in most cases were broken in a similar manner.

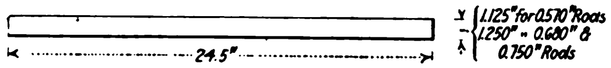


FIG. 4. CHILL-CAST BARS

It is important to note that this phenomenon has never occurred (at least in the writer's practice) with other alloys, such as different kinds of brasses, bronzes, aluminum alloys, etc. The explanation we have to seek in the structure of the alloy.

ROLLING AND DRAWING

The cast rods were cropped off, the skin removed by forcing through sharp dies, they were then annealed, cold rolled and drawn, annealing being applied between passes. The skin was removed also before drawing, and, besides, sometimes between some draws.

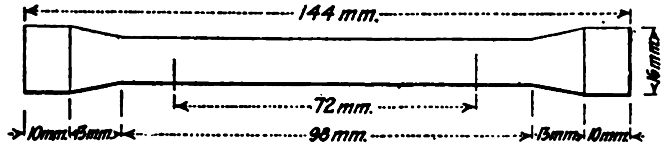


FIG. 5. TEST BARS

Fig. 3 shows the dimensions of sand castings, corresponding to finished bars of various diameters.

Fig. 4 shows chilled castings which correspond to the finished bars of final diameters 0.570, 0.680 and 0.750 in.

TENSILE TESTS

Lots Nos. 1, 2, 3, 4 and 21 contained about 10 per cent of aluminum; the rest of the lots were cast of an alloy containing about 9 per cent of aluminum. Several test bars (see Fig. 5) were taken from every lot and were pulled on a Mohr and Federhaft machine. The averages of these results are given in Table I.

As to lot No. 21, which was subjected to high, medium and low forging; the difference in the degree of forging was attained by first removing different amounts of skin by means of a sharp die. The less skin removed, the greater the forging subsequently applied.

Concerning lot No. 34 it should be noted that metal cast and quenched immediately in cold water shows less ductility and tensile strength than the same cast when slowly cooled.

To the writer's regret this work, because of circumstances, was discontinued and no more data were obtained. Therefore no positive conclusion can be drawn as to the nature of the peculiarities appearing. Referring to the equilibrium diagram (Fig. 1) it might be said, however, that in both cases (rapid quenching in cold water and slow cooling) we would expect to get only the alpha solution.

CONE SHAPED FRACTURE

Some of the rolled bars 1.240 in. in diameter were experimented with for the manufacture of primers. The bars were cut into cylinders and cold pressed in a hydraulic press, the faces being perpendicular to the axis. Sometimes the cylinders could not withstand the pressure and were consequently broken, always in a characteristic way, a cone shaped piece coming out of the top, as shown in Fig. 6.

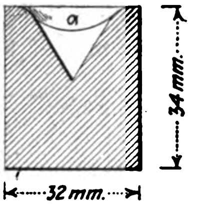


FIG. 6. SECTION OF PIECES WHICH FAILED UNDER COMPRESSION

Attention is called to this fact in connection with the breaking of rods during cold rolling, as was previously illustrated in Fig. 2. This phenomenon reminds one of the fracture of malleable cast iron under pressure.

MACHINING

Machining these alloys is not difficult. Small pieces, of course, will crack if not machined at medium speed, with good tools and with a cooling solution.

Washington, D. C.

Glauber's Salt in Siberian Lakes

The following is an estimate of supplies of precipitated Glauber's salt in some of the Siberian lakes: (1) The Great Marmyshansk Lake—144,000,000 poods (2,600,000 short tons) of crystalline salt ($Na_2SO_4 10H_2O$) and 22,000,000 poods (397,210 short tons) of evaporated Glauber's salt; (2) Little Marmyshansk Lake—25,000,000 poods (451,400 short tons) of crystalline salt; (3) Lake Tuskal (Minusinsk district)—up to 100,000,000 poods (1,805,500 tons) of crystalline salt; (4) Lake Varche (Minusinsk district)—up to 100,000,000 poods (1,805,500 tons) of precipated crystalline salt and an enormous quantity of Glauber's salt in solution.

Samples Exhibition to Be Held at Trieste

Consul O'Hara cables from Trieste that an announcement has been made of a permanent samples exhibition to be held at Trieste under the auspices of the Chamber of Commerce. A special building will be erected for the purpose, which is expected to be ready by next summer. The consul considers this an excellent opportunity for American exporters to display their goods.

Electrical Treatment of Sewage—Landreth Process*

SEVERAL electrolytic methods have been suggested for the purification of sewage. The first to be experimented with, the invention of Webster, was installed at Corness, England, in 1889. In this process the raw sewage flowed in contact with iron electrodes through long troughs; a current of 0.9 amp. was maintained by an e.m.f. of about 2 volts. For treating raw sewage the estimated consumption was 240 lb. of iron and 450 kw.-hr. per million gal. In this process the oxygen liberated at the anode was mostly consumed in oxidizing the iron electrodes; the oxides thus formed acted as a precipitating agent for the sludge of the sewage; the process was therefore chemical rather than electrical. The second process to be experimented with attempted disinfection by means of nascent chlorine liberated by the electrolysis of a soluble chloride. In the earlier installations a chloride was mixed with the sewage and the solution electrolyzed; later sodium hypochlorite produced electrolytically was added to the sewage. In 1893, at Brewster, N. Y., this latter method was used under the direction of the New York City Health Department. About 1600 lb. of salt was used per million gal. and the plant required 700 amp. at 5 volts.

Kennicut, Winslow and Pratt[1] summarize the electrolytic methods of treatment so far developed as being a question of the cost of supplying the disinfectants and precipitants needed; usually this cost is not in favor of electrolysis in the presence of sewage.

The failure of sedimentation thoroughly to clarify sewage led to the introduction of the chemical precipitation method, and lime was the first precipitant to be used. This method is open to the objection that the addition of too much lime renders varying amounts of the suspended organic matter soluble, which causes the effluent to be more putrescent and obnoxious than that from ordinary sedimentation.

THE LANDRETH DIRECT OXIDATION PROCESS

In the Landreth direct oxidation process for the treatment of sewage, both electricity and lime are employed. The efficiency of the process depends on the combination of these two agents; neither alone produces as good results. Oxygen and hydrogen liberated at the electrodes in the nascent state are claimed to promote the destruction of pathogenic bacteria, also to reduce nitrogenous matter to nitrites, nitrates and carbon dioxide. The presence of lime furnishes an alkaline medium and renders the electrodes passive, thereby reducing the amount of iron going into solution; the lime also assists sedimentation. This process was extensively studied at a 750,000-gal. plant at Elmhurst, L. I., in 1915, later at Decatur, Ill. During the spring of 1918 a million-gal. plant was constructed at Easton, Pa., by Mr. Landreth for demonstration purposes.

DESCRIPTION OF PROCESS

The raw sewage upon entering the plant passes through a coarse screen over a screen having six 0.25-in. holes per sq.in., is then elevated by a centrifugal pump passing over a measuring weir to the electrolytic tanks, then through an observation flume and is discharged either through a sedimentation tank or direct to the river.

The electrolytic apparatus consists of a horizontal cypress box 27 ft. 3 in. long, 3 ft. wide and 2 ft. 9 in. deep. The removable top is constructed in two sections and can be made watertight by means of bolts and rubber gaskets. Each section of the top is vented for the removal of the gaseous products of electrolysis. A series of valves at the bottom of the tank serves for the removal of sludge.

Internally the tank is divided into eleven spaces, each of which contains two banks of electrodes mounted one above the other, giving a total of 22 banks of electrodes arranged in two horizontal rows of eleven each. These banks of electrodes, each of which consists of 48 plates of mild steel 10 in. by 16 in. by $\frac{3}{16}$ in. spaced $\frac{3}{8}$ in. apart, are placed across the box, the plates being vertical and parallel to the sides. The 48 plates of each bank are electrically connected so that alternate plates have the same polarity, the 22 banks being connected in series. The tank is so constructed that the entire flow of sewage is through the $\frac{3}{8}$ in. spaces between electrodes. Paddles revolve in each of the spaces between electrodes at 20 r.p.m. The total electrode area is 124,287 sq.in.

DESCRIPTION OF OPERATIONS

Milk of lime is added at the measuring weir by an apparatus which permits of close regulation, and the amount added is sufficient to give about 30 p.p.m. excess CaO in the effluent. The polarity of the electrodes is changed at regular intervals to reduce polarization. Calcium carbonate tends to crystallize on the electrodes and has the effect of increasing the power required by the stirrers; whenever the power consumption reaches 2000 watts the addition of lime is discontinued. The acid in the raw sewage dissolves these crystals, reducing the power consumption to normal, or to about 1100 watts, when lime is added again at the inlet of the tanks. During this operation lime is added at the observation weir. The voltage of the individual cells ranges from 2.5 to 3.7 volts, averaging 2.82 volts with a current of 34 amp.

EFFICIENCY AND COSTS

The efficiency of any method of sewage treatment cannot well be shown by a tabulation of results, due to the large variation of the raw sewage and to the means of disposal of the effluent; these are determined by local conditions. It is usual to design a plant to meet these conditions. The amount of dissolved oxygen absorbed by an effluent is an important standard; the effluent from the Landreth process is below the most stringent standard in this respect. The average absorption of dissolved oxygen upon standing five days was 0.77 p.p.m., whereas the very strict standard of the Royal Commission on Sewage Disposal allows 30 p.p.m. as a maximum. The effluent produced by the Landreth process is considered highly satisfactory.

A million-gal. plant would consume power at the rate of 335 kw. and 90 per cent lime at the rate of 800 lb. per million gal. A typical plant for treating sewage from a town of 55,000 population can be operated at a cost of 64c. per capita. An "activated sludge" plant would cost $1.10 and an "Imhoff-trickling filter" plant 82c. per capita. A Landreth plant has the additional advantage that it requires only a small ground area and can be operated and installed in a thickly populated district without being offensive.

---

*Abstract, *J. Frank. Inst.*, vol. 188, No. 2, p. 157.

[1] Kennicut, L. P., Winslow, C. E. A., and Pratt, R. W.: "Sewage Disposal," 1919, John Wiley & Sons, New York.

Effect of Surface Tension on Crystalline Form*

By Cecil H. Desch
Professor of Metallurgy in the Royal Technical College, Glasgow

THE investigation which forms the subject of these reports was undertaken at the instigation of Sir George Beilby to test the hypothesis of Quincke, according to which metals and other substances, immediately before solidification from the liquid state, separate into two immiscible liquids, one of which is formed in much smaller quantity than the other. These liquids have an interfacial surface tension, and a foam is formed, the liquid present in smaller proportion arranging itself in cell walls, and the second constituting the cell contents. Crystallization then takes place within the foam cells, and the cell walls are represented in the solid mass by the boundaries of the crystal grains.

If this were actually the case, the form of the crystal grains in a solid metal might be expected to approximate to that of the cells in a foam, such as is produced by blowing air through a soap solution, the shape of the cell walls in both cases being due to surface tension. The subsequent growth of the crystals forming the cell contents might distort the original cells, but could scarcely produce a complete change of type.

Theoretical Form of Foam Cells

The problem of the form of individual cells in a foam has received surprisingly little attention. The fundamental principles were established by Plateau in his classical investigations,[1] and may be stated as follows:

(*a*) Only three films can meet in an edge, and they must make equal angles of 120 deg. with each other;

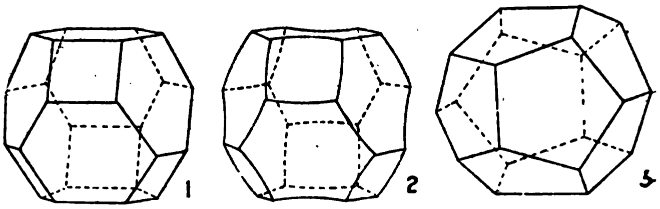
(*b*) Only six films can meet at a point, and adjacent edges must make equal angles of 109 deg. 28 min. with one another.

The foam being the result of surface tension, the area of each cell is necessarily a minimum for the given conditions. The arrangement of the dividing walls in a single layer of bubbles on the plane surface of a liquid is easily shown to be a regular hexagonal pattern.

The beautiful experiments of Plateau did not include the examination of a mass of foam. A solution of this problem was obtained by Lord Kelvin.[2] The most general solution for the homogeneous division of space was shown by him to be a tetrakaidecahedronal cell, consisting of fourteen walls, which may be plane or not plane (Figs. 1 and 2). Eight of these are hexagonal and four quadrilateral, so that there are thirty-six edges and twenty-four corners. Each face is common to two neighboring cells; each edge is common to three cells, and each corner is common to four cells. Any homogeneous assemblage of similarly shaped and similarly oriented objects, however irregularly shaped, may be divided from one another by similar cells of the above type, in such a way that every single object is completely inclosed in one cell. The simplest example of such a cell may be obtained by truncating the six corners of a regular octahedron to such a depth that the eight original triangular faces are reduced to equilateral equi-angular hexagons.

Foam cells are subject to the further condition that the partitional area must be a minimum. The tetrakaidecahedron of minimum area has been shown[3] to have also eight hexagonal and six quadrilateral faces, all the edges being equal in length; but the latter, instead of being straight lines, are now similar plane arcs. The condition being that the edges must meet at an angle of 109 deg. 28 min., each arc is one of 19 deg. 28 min. It is not actually circular, but may be considered as such without serious error. The figure may be constructed very simply by stiff brass wires soldered together to form the required figure. Such a wire model, immersed in soap solution, gives a giant foam cell, the faces of which have the required form. The hexagonal films are doubly curved in such a way that the three diagonals are straight lines lying in one plane, and the sum of the curvatures in mutually perpendicular normal sections at any point is constant. A mass of foam built up of similar cells of the above shape would be stable.

The rhombic dodecahedron, Fig. 8, is a plane-sided polyhedron, of which each pair of sides meets at an angle of 120 deg., and space may be filled with equal and similar rhombic dodecahedra. Moreover, it is the only plane-sided polyhedron which fulfills these conditions, but foam cells of this form are unstable, since it involves the meeting of twelve plane films at a point, an unstable equilibrium which may be departed from in three different ways.



FIGS. 1 TO 3

Fig. 1—Tetrakaidecahedron with plane faces. Fig. 2—Tetrakaidecahedron of minimum area. Fig. 3—Regular pentagonal dodecahedron.

Experimental Examination of Foam Cells

In order to prepare a foam, some solution is poured into a glass trough with plane parallel sides, and air is blown through it by means of a narrow pipette until the trough is filled with foam. When a fairly stable condition has been reached, single cells are examined by placing the trough in front of a window, screening it with a sheet of black paper having a hole about 2 cm. in diameter, so that the attention is more easily concentrated on a single cell. An attempt is then made to count the cell walls, and to record the number of edges of each face. This is done for as many cells as possible. The direction of curvature of the walls may often be recognized by the arrangement of the bands of color under illumination. A second method consists in making a foam from a warm solution of gelatin, of sufficient concentration to set on cooling. The foam cells are thus fixed, and may be examined at leisure, each cell being cut open and examined in turn by using fine-pointed dissecting scissors. Both methods have been employed in obtaining the results shown below.

---

*Second report (slightly condensed) to the Beilby Prize committee of the Institute of Metals on the solidification of metals from the liquid state, presented Sept. 24, 1919. The first was presented to the Institute at the spring meeting of 1914, and consisted of a review of the state of knowledge respecting the solidification of metals from the liquid state.

[1] J. Plateau, Statique expérimentale et théorique des liquides. 2 vols. Ghent, 1873.

[2] *Proceedings* of the Royal Society, 1894, vol. 55, p. 1; Collected Papers, vol. 5, p. 333.

[3] *Philosophical Magazine*, 1887, vol. 24, p. 503; Collected Papers, vol. 5, p. 297.

The forms of the cells were found to be essentially the same in all cases.

Even a casual examination of a mass of foam shows that the individual cells vary in form, but however irregular they may appear, it is easily seen that the faces and edges fulfill the conditions established by Plateau. Occasionally, when movements are in progress in the midst of the mass, four films may be seen to meet in one edge, but the position is unstable, and sliding immediately takes place until equilibrium is reached. The vertices of large cells are often truncated, and a small cell is then interposed between the larger neighbors. Such transitional cells are either hexahedra, elongated in one direction, and having the edges slightly curved so as to make angles of 109 deg. 28 min. with one another instead of 90 deg., or tetrahedra, the edges of which must be strongly curved.

TABLE I—STRUCTURE OF FOAMS

Material	Average Number of Faces to Each Cell	Number of Sides to a Face 3	4	5	6	7	8
Plateau's solution	13	2	52	128	57	18	..
Ammonium oleate	13	1	54	130	64	10	..
Soap solution	..	3	23	39	18	..	..
Soap solution	..	4	36	87	53	12	2
Gelatin	10.5	..	18	36	6	3	..
Gelatin	10	1	10	26	13	1	2
Gelatin	9	2	18	20	6	1	..
Gelatin	11	8	41	46	35	6	..
Gelatin	..	..	16	40	17	..	..
Totals		21	268	552	269	51	4

(The first two preparations, in which the largest number of cells was counted, were the most regular in structure. Some cells proved to be complete pentagonal dodecahedra. The gelatin preparations, no doubt owing to viscosity, were the most variable.)

The results of observations of several masses of foam, prepared at different times and by different methods, are given in Table I. It is at first sight surprising that an approximation of Lord Kelvin's tetrakaidecahedron should be so rare. If this were the usual type of cell, four- and six-sided cell walls would occur with frequencies in the ratio of 6 to 8, but the observations show that five-sided faces are much more common than either, and that hexagonal faces are comparatively infrequent. The cells often approach very closely to the form of a regular pentagonal dodecahedron (Fig. 3). This figure has faces with five equal angles of 108 deg., thus coming very near to the required angle of 109 deg. 28 min., and adjacent faces meet at an angle not far from the equilibrium value of 120 deg. A slight curvature of the edges therefore converts the pentagonal dodecahedron into a possible figure of equilibrium for a foam cell.

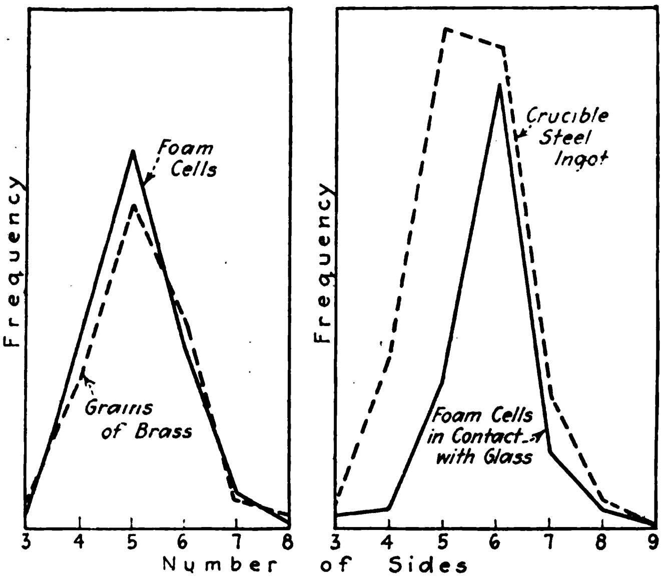
EXPERIMENTAL EXAMINATION OF CRYSTAL GRAINS

The next step is to examine the forms of crystal grains in cast metals, and to determine how far they correspond with those of foam cells. For this purpose advantage was taken of a fact mentioned by Professor Huntington in the discussion on the previous report,[4] that β-brasses containing aluminum, when immersed in mercury, separate into distinct grains, the mercury penetrating between the grain boundaries. A suitable mass of metal was available, and the coarse grains thus isolated had a brilliant, silvery surface, owing to amalgamation. They could be examined under a hand lens, each face being marked with a dot of ink after noting the number of its sides and the direction of its curvature. The results of the examination of thirty of these grains are shown in Table II. The number of faces is usually large, varying from 11 to 20, with an average of 14.5. Generally speaking, the larger grains are the more complex. The faces are mostly curved, and double curvature, recalling that of foam cell walls, is frequent. It will be seen that there is a great preponderance of pentagonal faces. The figures are plotted in Fig. 4 for comparison with those given by the counting of cells in soap and gelatin foams, and the general resemblance of the two curves will be noticed.

Attempts have also been made to separate other metals in the same way, but the number available was small, and it was not thought worth while to present the figures separately.

EFFECT OF SUPERFICES

The preceding remarks concerning the forms of foam cells and crystal grains are applicable only to cells which occur in the midst of a large mass, and are therefore independent of boundary condition. Where the wall of a foam cell meets a solid surface, such as the glass of the containing vessel, it does so at an angle of 90 deg. The partitioning of neighboring cells is still subject to the condition that only three walls can meet at an edge, and that the angle between them must be 120 deg. The most natural arrangement then becomes a regular hexagonal pattern. Actually, as the cells very in size, polygons having a variable number of sides are observed, but the hexagonal form predominates. Figures for soap and gelatin films are given in Table III, and are represented graphically in Fig. 5.



FIGS. 4 AND 5

Left—Shape of brass grains compared to foam cells. Right—Shape of boundary grains of ingot compared to foam cells.

TABLE II—GRAINS IN PROPELLER BRASS IN β-CONDITION

Material	Average Number of Faces to Each Grain	Number of Sides to a Face 3	4	5	6	7	8
β-brass	14.5	11	88	190	123	20	3

A convenient metallic object for comparison was a small ingot of crucible steel, the fracture of which showed dendritic crystals extending from the four surfaces to the center of the ingot. One of the outer faces was polished and etched, so giving a transverse section of the dendritic crystals close to their origin.

---

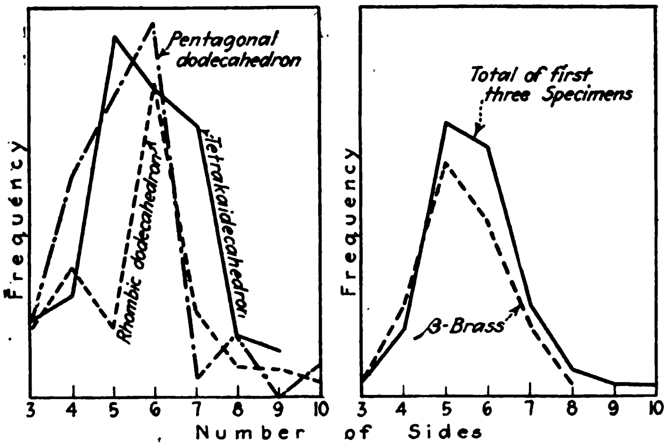
[4] Journal of the Institute of Metals, No. 1, 1914, vol. 11, p. 108.

The polygonal outlines thus exposed were examined as above and the results are shown in Table IV and Fig. 5. Some of the grains were very complex, and it is probable that a certain amount of coalescence takes place between neighboring dendrites, giving rise to compound grains, the outlines of which are more or less irregular.

While it has only been found practicable to examine isolated crystal grains in exceptional cases, it is always possible to make plane sections through the metal, and to examine the shape of the grain boundaries exposed in that section by etching. Such boundaries often have a simple polygonal form, and it would appear at first sight that it should be possible, by counting the sides of a sufficiently large number of polygons, to infer from the result the probable form of the polyhedra of which they are the sections, provided that those polyhedra are either similar or vary closely about a mean type. Unfortunately, the problem of establishing a relation between the form of a polyhedron and that of its plane sections proves to be peculiarly difficult. The mathematical problem on which the solution depends may be stated simply. It is: given the form of a polyhedron, what is the probability that a plane section, drawn through it at random, will have 3, 4, 5, . . . *n* sides? A general solution, even for a simple case, such as a cube, does not appear possible. One is therefore reduced to some geometrical expedient.

A rough experimental method has been adopted, models of the polyhedra being made in cardboard, and rendered waterproof. By immersing these, plane sections are realized by the intersections of the model, placed in various positions, with the surface of the water. Placing the model with a selected line vertical, it is immersed by successive equal steps, such as 1 cm., and the form of the intersection is noted at each step. Experiments of this kind have been made with models of the rhombic dodecahedron, pentagonal dodecahedron, and orthic tetrakaidecahedron.

As an illustration of the method adopted, the first of these solids may be taken. The model may be immersed with one face horizontal. The height of the model employed being 13 cm., 14 sections at distances of 1 cm. are obtained, of which 8 are four-sided and 6 are six-sided. As there are 12 rhombic faces, to any one of which the section might be parallel, these numbers must be multiplied by 12. Similarly, any one of the 24 edges might be placed horizontally, like the ridge of a roof, or a vertex might be placed uppermost, there being 8 trihedral and 6 tetrahedral vertices. A vertex being tilted to one side, a fresh set of observations is made, and so on. The curve drawn in Fig. 6 represents the relative frequency with which each section occurs, a total of 1732 sections having been used for its construction. The curves for the other polyhedra have been constructed in the same way.



FIGS. 6 AND 7

Left—Number of sides on figure cut from crystals by random planes. Right—Shape of crystal intersections in metallographic prints.

There is no certainty that sections thus arbitrarily chosen will be distributed in the same way as those found at random, but the number taken is large, and it seems worth while to test it. Small errors may also be introduced by accidental irregularities in the models. The metal specimens used for comparison with the above figures included the same brasses which had furnished the isolated grains, two pieces of very mild steel, having polygonal grains with remarkably straight boundaries, and several miscellaneous specimens which were used for purposes of comparison. The results are shown in Table V, and are represented graphically in Fig. 7.

An examination of the tables and curves makes it evident that little information is to be gained from a study of the cross sections of crystal grains, at least until greater certainty can be reached as to the relation between the form of a polyhedron and the probability that a section cut through it at random will have a given number of sides. If the curves shown in Fig. 6 represent anything like the proper distribution, it would be difficult, if not impossible, to infer which was the true form of the polyhedron approaching most nearly to the average crystal grain, as the distribution is not sufficiently characteristic.

TABLE III—CELLS IN CONTACT WITH GLASS

Material	Number of Sides to a Cell						
	3	4	5	6	7	8	9
Soap solution	1	8	12	55	15	3	..
Soap solution	8	10	55	100	28	7	..
Gelatin	..	1	17	22	2	3	1
Totals	9	19	84	177	45	13	1

TABLE IV—GRAIN BOUNDARIES AT COOLING SURFACE OF INGOT

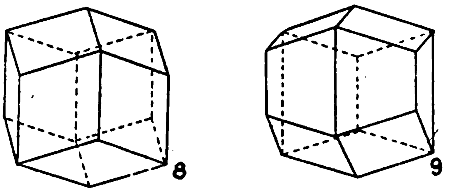
Material	Number of Sides to a Cell						
	3	4	5	6	7	8	9
Crucible steel	5	44	93	93	27	6	1
Crucible steel	3	44	135	126	32	2	..
Totals	8	88	228	219	59	8	1

TABLE V—CRYSTAL GRAINS SEEN IN PLANE SECTIONS

Material	Number of Sides to a Grain						
	3	4	5	6	7	8	Over 8
Mild steel rod	5	61	299	245	93	16	7
Mild steel casting	4	17	67	64	7	..	..
Propeller brass	9	24	57	70	36	18	6
β-brass ingot	9	50	137	102	43	6	..

ASSUMPTION OF EQUIDISTANT NUCLEI

If we suppose that surface tension has nothing to do with the form of the crystal grains, but that these are determined solely by growth from centers, a conclusion may be reached as to the form to which such grains should approximate. It seems likely that in a sufficiently large mass the nuclei should be approximately equidistant. This would be equivalent to the close packing of a large number of spheres. It is known that such close packing may take place in one of two ways, known respectively as the cubic and the hexagonal. If we imagine closely packed spheres to be made of some deformable substance, such as plasticine, and pressure to be then applied so as to close up the interstices, a mass of polyhedra will result. Cubic packing leads to the formation of regular rhombic dodecahedra, and hexagonal packing to that of dodecahedra which have certain of their faces no longer rhombs, although still quadrangular. (See Figs. 8 and 9.[5]) Whichever were formed, the grains would have quadrangular faces, and in a mass of metal solidifying under such conditions the grains might be expected to show a preponderance of 4-sided faces. This is not confirmed by the observation of grains isolated by the mercury method. If, however, the form of the grains were determined by surface tension, they might be expected to approach more closely to the pentagonal dodecahedron, or to the tetrakaidecahedron, or to some compromise between the two. This is confirmed by the results shown in Fig. 4, there being a marked preponderance of faces with 5 edges, followed by 6 and 4.



FIGS. 8 AND 9

Fig. 8—Rhombic dodecahedron from cubic packing. Fig. 9—Dodecahedron from hexagonal packing.

Relation Between Directional Impulse and Surface Tension

There is thus evidence that the forms of the crystal grains in at least some metals are such as might be expected if surface tension were concerned in their determination. On the other hand, it is well known that many crystal grains are less simple, and exhibit complex interlocking. There is a striking difference between α- and β-brasses in this respect. α-brasses usually have interlocking boundaries, and rarely approach simple polyhedral forms. Iron and steel may form either polyhedra or interlocking grains, according to circumstances. One is forced to the conclusion, previously expressed by the writer,[6] that two forces are competing in the formation of crystals. One is the directive force of cohesion, sometimes called the crystallizing force, and the other is surface tension. The ratio which the one bears to the other varies with the nature of the crystalline substance, the temperature of crystallization, the composition of the mother liquor, and the absolute dimensions of the mass of the solid. When the mass is very small, so that the surface is large relatively to the volume, the surface forces may be so great as to mask the crystallizing tendencies completely. This aspect of the subject has been specially studied by Sir George Beilby.[7] With larger masses the other factors become more important, and the specific differences between different metals become particularly noticeable. It will be seen, however, that a metal which has a great power of orientation will be likely to form interlocking grains, as the boundaries will be chiefly determined by the growth of the crystallites, while a second metal, in which the orienting forces are weaker relatively to the surface forces, will tend to form grains of a simpler character, surface tension intervening to check the growth.

Reference may here be made to one case in which an isolation of crystal grains has been effected, but in which only complex forms have been observed. This is the case of glacier ice, the crystals of which have not been formed directly from the liquid state, but re-formed from the original minute snow crystals by successive partial fusion and regelation under the influence of non-uniform pressure. The action of sunlight sometimes causes a mass of glacier ice to disintegrate into grains, which are readily separated from one another. These grains do not appear to be of simple form, but interlock in a complex fashion. "The shape of the grains is irregular, and no two of them are alike, but they fit into each other like a puzzle. They resemble a collection of vertebræ more than anything else."[8] It is not proved that such disarticulated masses, which vary in size in a single mass of glacier ice from ½ to 700 g., are actually single crystal grains, and it may well be that they are aggregates of smaller units, but they are differentiated from the general mass by the ready fusion of the thin sheath of eutectic surrounding them, so that sunlight etches the outline of the grains on the inner surface of a grotto, revealing interlocking boundaries curiously resembling the sutures of the cranial bones.[9] It is quite possible that two orders of cellular structure are here present, this being a feature common to many solidified masses, both metallic and non-metallic.

Chicago Women Chemists' Meeting

The women chemists of Chicago recently held an informal meeting during which the discussion was devoted to the coming meeting of the Chicago Women's Section and other pertinent topics.

The second informal dinner for women interested in chemistry is scheduled for the evening of Jan. 12 at 6:30, at the Chicago College Club, 151 N. Michigan avenue. These meetings are the result of the attendants being drawn together by common interest. Among subjects for future discussion are planned the starting of business in the tanneries, pleasing the fastidious with specially dyed costumes, and similar experiences.

The Chicago Chemist Club

The Chicago Chemist Club has elected the following officers and trustees to permanent positions during the coming year: President, William Hoskins; first vice-president, Frank M. DeBeers; second vice-president, W. Lee Lewis; treasurer, Charles E. Kawin; secretary, Paul Van Cleef; trustees: one-year term, Otto Eisenschmil; two-year term, F. W. Willard, L. V. Redman; three-year term, H. O. Baker. Final arrangements have not yet been made with respect to the future headquarters of the club. Among other proposals is the use of the City Club as headquarters for the time being.

International Research Council Monographs

Professor W. A. Noyes of the University of Illinois has been recommended by the Advisory Council of the American Chemical Society as chairman of the Board of Editors of the Scientific Series of Monographs and Dr. John Johnston has been recommended as chairman of the board of editors of the technological series of monographs which are to be prepared under the auspices of the International Research Council.

---

[5] W. Barlow and W. J. Pope, *Transactions* of the Chemical Society, 1907, vol. 91, p. 1158.

[6] *Proceedings* of the Royal Philosophical Society of Glasgow, 1912, vol. 43, p. 114.

[7] *Procedings* of the Royal Society, 1903, vol. 72, p. 226.

[8] J. Y. Buchanan, *Antarctic Manual*, 1901; Comptes Rendus of Observation and Reasoning, p. 48. Cambridge, 1917.

[9] Good photographs are given by J. Y. Buchanan, *Proceedings* of the Royal Institution, 1909, vol. 19, p. 243; *op. cit.*, p. 238.

Research Organic Chemicals*

Brief Sketch of the Development of Domestic Supplies of Organic Intermediates for Laboratory Research —Illinois Vacation Quantity Synthesis Course—Department of Synthetic Chemistry, Eastman Kodak Company

BY H. T. CLARKE

UNTIL 1914 the great bulk of organic chemicals employed by research workers in university and technical laboratories was obtained exclusively from Germany, the majority being supplied by the firm of C. A. F. Kahlbaum. This firm engaged in the preparation of a certain number of the products which it listed, but the majority were undoubtedly procured from outside sources. These fell into three main classes. The first class consisted of firms making a specialty of the preparation of rare chemicals, of which the most important was that of Theodor Schuchardt of Corlitz. The second class consisted of manufacturers of specialties in which there was scant room for competition and in which one firm apparently supplied the world's demand. Examples are the essential oil laboratories of Schimmel & Co., which supplied a relatively large field, and small firms such as that of Flemming, which prepared the chlorhydrins of glycerol. The third class consisted of the large chemical manufacturers, such as the important dye and pharmaceutical plants.

Owing to the wide range of products thus obtainable from the second and third classes it was possible to supply chemical research workers a large number of necessary products at relatively low cost. The special materials prepared by Schuchardt and Kahlbaum were naturally very much more expensive, since they were prepared on a laboratory scale rather than in large scale apparatus. For example, p-nitrochlorbenzene could be purchased in pure condition for 15 marks a kilo, and in technical quality for 6.50 marks a kilo, the latter material being obtained from the dye works. On the other hand the corresponding bromo compound, which is just as readily prepared in the laboratory, was priced at 0.40 mark per kilo. Again technical p-toluidine, sold at 4.40 marks a kilo, was prepared from technical p-nitrotoluene, sold at 3.50 marks a kilo, whereas p-chloraniline, obtained from technical p-nitrochlorbenzene, was sold for 10 marks per hundred grams. The procedure of preparation is identical, but in the latter case it was not carried out on a technical scale.

At the opening of hostilities in 1914 the supply of Kahlbaum research chemicals in this country was abruptly cut off. Research work continued for some time with the use of materials in the stock houses and in the store rooms of the universities, but by the middle of 1916 the position was rapidly becoming serious and it looked as if research work was coming to a halt for lack of supplies.

RESEARCH STUDENTS PREPARE LARGE QUANTITIES OF ORGANIC CHEMICALS

During this period one attempt was made by a university laboratory to meet the shortage in its stock rooms. Dr. C. G. Derick, of the University of Illinois, initiated a system of vacation laboratory work for the senior students in the organic chemical department, in which the materials most urgently required for the work of the coming semester were prepared in quantities sufficient to meet the immediate requirements. It may here be pointed out that this admirable scheme was of direct benefit not only to the chemical laboratory of the University of Illinois but to the students taking part in the manufacture, since in no other way would they be able to obtain the experience which was rendered possible by this system. On the retirement of Dr. Derick the work was continued under the direction of Dr. Roger Adams, who took it over at the time when the shortage of research organic chemicals was becoming acute. Dr. Adams therefore decided to throw open the facilities of his laboratory to chemists throughout the country, and by so doing was able to bring relief to the quarters where the distress was greatest. On the entry of the United States into the war this work at the University of Illinois was extended, and the laboratory was able to afford material assistance to the Government by synthesizing small quantities of chemicals unobtainable elsewhere.

EASTMAN SYNTHETIC ORGANIC CHEMICAL LABORATORIES

In July, 1918, a letter was published in *Science* from Prof. R. A. Gertner, appealing for an endowment of a laboratory in which this work could be carried out on a more extensive scale. It appeared to the Eastman Kodak Co. that its laboratory was in a favorable position to undertake the preparation of synthetic organic chemicals; and approval of the American Chemical Society was obtained, while ample assurance of support was readily given by the large chemical manufacturing firms in the country. Owing to the scarcity of chemists at that time it was decided to staff the laboratory entirely with women, both as chemists and as assistants, and this plan has been adhered to throughout the progress of the work.

The activities of the department of synthetic chemistry, as it is called, fell into three main classes: Firstly, the synthesis of materials for which there is no other source of supply; secondly, the purification of intermediate and other chemical products which could be obtained from manufacturing firms, and thirdly, the distribution of these chemicals. It was decided not only to sell pure chemicals but also to make available to research workers the various dye intermediates and technical products which could be obtained from the manufacturers. The firms manufacturing such chemicals do not welcome orders for small amounts of their products such as would meet the requirements of laboratory workers, but have willingly supplied not only 50 to 100-lb. lots of the products which they place on the market, but also many of those which they prepared exclusively for their own use. The retailing of small amounts of such materials to the chemical public is thus of benefit both to the consumer and the producer.

---

*Read before the Fifth National Exposition of Chemical Industries, Chicago, September, 1919.

In addition to these technical chemicals and the pure chemicals prepared from them, there are available a number of products which, while not of the highest grade, are yet sufficiently pure for general synthetic purposes. These chemicals can naturally be held at a lower price than those of the highest purity, since in many cases more than half of the cost of the pure products is represented by purification.

Synthetic organic chemicals of value in general research have been obtained from the pharmaceutical and perfume manufacturers such as Parke, Davis & Co., Frederick Stearns & Co., the Abbott Laboratories, the Florasynth Laboratories, Antoine Chiris & Co., Van Dyk & Co. Particular mention should be made of the Dow Chemical Co., which has in several instances made special runs of particular organic chemicals otherwise unobtainable in quantity.

Continued assistance comes from the University of Illinois and from certain individuals in other university laboratories. It should here be mentioned that the excellent methods published by the University of Illinois have in many cases been adopted by commercial firms.

SIX HUNDRED COMPOUNDS LISTED

At the present time, only a few months after the beginning of the undertaking, the list includes nearly 600 different compounds, the majority of which are pure. Two considerations have influenced the selection of the substances prepared: on the one hand, attempts have been made, whenever feasible, to supply compounds for which especial inquiries had been made; on the other, the choice of new preparations has been largely determined by the materials at hand. Extensive use has been made of the ready availability of certain products which were hitherto considered as little more than chemical curiosities.

FIRMS PRODUCING SPECIALTIES

During the past year several concerns have started the manufacture of some of the less common organic chemicals, the demand for which is not as great as is the case with dye intermediates. Mention may be made of the Digestive Ferments Co. and the Special Chemicals Co., which are manufacturing a line of pure bacterial sugars and allied compounds. The last named firm, which was organized primarily for the purpose of assisting to make the United States independent in research chemicals, is also supplying a number of general organic reagents, as are the Eimer & Amend Co., the Cyclic Chemical Co., the Research Laboratories of Chicago, the Organic Products Co., the Saginaw Laboratories and others.

CO-OPERATION REQUIRED

In order that production of research organic chemicals should be a success, it is essential that they have the support of the universities, especially during the first few years. It cannot be denied that with the present state of labor the cost of research chemicals will be considerably higher than the prices at which Germany was able to sell them before the war, and should Germany find a market for its products in this country during the initial period, there can be no doubt that the attempts to render the United States independent of Europe in these commodities will have to be discontinued.

Their continuance is, moreover, contingent upon the success of the American chemical industries, since it is from these industries that the basic materials for the preparation of the research products must be obtained. But the success of the chemical industries depends in the long run upon the continuation of chemical research, for the country where chemical research of a theoretical nature is most intensely pursued will be the country to lead in chemical technology. The by-products of the researches carried out by university workers have formed and will form the basis of new technical processes and products.

It is therefore necessary that the materials for the carrying out of research work be close at hand; a research worker who wishes to experiment on a new line and requires special materials for his work is apt to lose enthusiasm if forced to wait three months or more for the arrival of the necessary starting products.

To further the success of chemical research and thereby to give the country the full advantages of their work, it is most advisable that university workers should co-operate as closely as possible. In order to avoid duplication of effort it would be well to permit a free exchange of new observations and products. The former is effected through the channels of the scientific publications, but very little has been done with regard to the organization of the exchange of materials. The Eastman Kodak Co. is accordingly inviting research workers to mail to it small quantities of new and interesting chemicals which they may prepare in the course of their work. Such chemicals can then be listed and distributed for research purposes. Great assistance would be afforded by universities if they were to follow the example of the University of Illinois in the undertaking above referred to, for this work has resulted not only in the output of urgently required chemicals, but—even more important—in the production of highly equipped chemists, upon whom as a class the future success of chemistry in the United States depends.

Japanese Decision on Trade Marks

The Supreme Court of Japan, in a suit instituted by a Philadelphia company for the protection of its trade mark rights, has handed down a decision which is of great importance to international trade.

The Miller Lock Co. adopted as its trade mark a scroll containing the name "Miller." This was registered in the U. S. Patent Office, Oct. 8, 1906, and in 36 other countries, date of registration in Japan being March 26, 1907. In 1916, it was found that the Crown Lock Co. of Tokyo was manufacturing imitations of the Miller padlock and stamping them with a fac-simile scroll containing the word "Crown" or "Million." Legal proceedings were instituted claiming infringement by means of the scroll containing the word "Crown." The Japanese Patent Office sustained the American owners of the trade mark. The case was then carried to the Supreme Court of Japan, which rendered a similar decision. The Court considered the question to be whether or not the imitation mark, notwithstanding the substitution of different English letters as embodied in the word "Crown" for the English letters constituting the word "Miller," would be sufficiently close to the registered mark to cause confusion in the minds of Japanese purchasers.

A Square Deal for the Electric Furnace*

By H. G. Weidenthal

THE advantages of the electric furnace have been dwelt upon individually and as a whole by the proponents of the various types and makes of furnaces, and to some extent the shortcomings of the electric furnace have been brought out and discussed. Among the users of electric furnaces the great majority are enthusiastic boosters, but it is true that a small minority have found that they made a mistake in choosing a type of equipment not suited to their particular class of work. In some instances the furnace was not sufficiently rugged to stand the strain, so that the cost of upkeep plus the lost time of delays has discouraged the user.

Lack of practical melting and general steel plant experience has caused trouble for more than one high-class designer making his first attempt on an electric furnace. Designers of steel plant equipment have learned by experience that simplicity and extreme strength are essential, because of the temperature conditions to be met and because of the mental attitude of men working around hot metal. When working in the heat and under the potential hazard prevailing around a furnace or mill, men are naturally less considerate of the welfare of machinery than men working under cooler and less hazardous conditions. Failure to recognize this on the part of some furnace builders has given grounds for criticism by old steel plant men. This is unfair to the electric furnace, for it can be designed sufficiently simple and rugged to meet steel plant requirements.

Sources of Apparent Dissatisfaction

Another source for apparent dissatisfaction among users of electric furnaces is directly chargeable to the users themselves. There are two classes of offenders. First, those who are familiar with the steel or casting business but do not appreciate the exclusiveness of the new equipment which they install. Instead of employing the proper men to operate the furnace intelligently, they buy it as they would a new cupola or a ladle and turn it over to some old "dyed in the wool" melter or blower to abuse as he sees fit. If this man is not exceptionally progressive, he has a fear of electricity and may even entertain hallucinations as to the effect of electric current on steel. At any rate he is seldom enthusiastic about his new care and does not give it a fair deal.

The second class of offender is the man or group of men who know little or nothing about the operating end of the steel business or casting business, whichever it may be that they embark upon. They have heard that the electric furnace runs itself and is the panacea for all the ills of the steel business. They expect by the use of this great device to sidestep the long years of apprenticeship and honest endeavor that the steel man has gone through to produce good steel. To them, pouring practice, ingot practice, cogging, forging and rolling, with their many very important details of temperatures, time of heating, etc., are merely unimportant details, for, as they think, "the electric furnace makes steel that cannot go wrong." They may even conclude that the so-called technique of steel manufacture is all unnecessary, but what happens when they try to market their product? The steel is piped, full of blow-holes, seams, slag, and they reverse their ideas and blame it all on the furnace. Is this fair to the electric furnace?

Now at last we come to the user who is getting satisfactory results and is really pleased with his electric furnace. He is a booster for the make of furnace which he has purchased and generally speaking he is well disposed toward all electric furnaces. Apparently he is doing all he can for himself and the industry, but is he really boosting the electric furnace to the unconvinced or partially convinced user of steel?

Electric vs. Open-Hearth Steel

It is a proved fact that properly made electric steel is far superior to open-hearth steel, and that the best makes equal and in certain cases excel crucible steel. Electric tool steels have made their mark and are here to stay. High-speed steels, alloy tool and plain carbon tool steels are being made which compare well with the best crucible grades. Electric alloy die blocks are giving exceptional service and promise to put the cheaper grades off the market. Some automobile manufacturers and makers of automobile parts are specifying electric steel for drive shafts, gears, and in a few cases for drop forgings. This last field is still in its infancy, but there the need for high-grade steel is very urgent. A large number of failures in drop forgings are due to dirty steel and segregations found in the open-hearth forging steels.

Forge shops making machinery forgings, shear blades, blanking dies, etc., are beginning to appreciate the merits of electric alloy steels and are using them quite extensively.

In the steel casting business only very few plants are specializing in high-grade and alloy steel castings, although a very profitable field is being developed for alloy steel castings. The majority are competing with converter and open-hearth castings, both in price and with regard to quality. It is quite true that by using the electric furnace as a melting unit and attempting little or no refining, it is possible to produce steel for castings at the same cost or in some cases even cheaper than by the converter or small open-hearth. Another reason for the use of an electric furnace for castings is the flexibility and ease of analysis control.

Trade Name Should Stand for Quality

It is perfectly legitimate for the casting manufacturer to take advantage of economies offered by the electric furnace, but if he does not make full use of the ability of the furnace to produce high quality steel, such castings should not be advertised as electric furnace product. The desire on the part of the manufacturer for large production and low cost should not become a reflection upon the electric furnace. It may be true that the trade does not demand a high-grade steel casting, but if "Electric Steel Castings" are sold to the trade, it should be supplied with material having a quality which is implied by the trade name "Electric Steel Castings."

Are the manufacturers of electric steel ingots, billets and bars producing the very best product that the furnace is capable of? Yes, some are producing excellent material, some are producing good material in the furnace, but are not careful enough about their pouring, mold practice, cooling, reheating, forging or rolling. Others make good steel most of the time, but feel that they cannot afford to remelt off heats, so they try to dispose of them either as their regular product or in some cases as open-hearth steel. Some of these heats are off in analysis, as was the case with one lately brought to the writer's attention which analyzed 0.065 phosphorus, but was sold as high-carbon chrome-vanadium shear blade stock requiring tool steel quality. Of course the steel failed and went back to the producer after the purchaser had lost a great deal of time and money trying to use it. Another very recent example is of some 3.5 per cent nickel steel for Navy work. The analysis was correct, but the steel was so full of non-metallic inclusions that it fell down miserably on its physical requirements. The writer is forced to admit that this steel was as bad or worse than any open-hearth steel he ever saw. It may be possible that in both of these instances the steel was made under adverse conditions such as bad bottom, bad roof or walls, forcing the operator to hurry the heat lest a breakdown catch him with his heat unfinished. This, however, is a poor excuse, for the proper course is that adopted by at least one plant which has a strict rule that no heat shall be rushed to completion because of furnace troubles, but that in such emergency the melter shall, as soon as possible, pour the heat without alloys. This material can only be used for remelting, and there is not even a temptation to apply it on an order. At the same time the cost of alloys is saved.

---

*Paper read at the meeting of the American Electrochemical Society in Chicago, Sept. 23-26, 1919.

MAJOR CAUSES FOR POOR HEATS

In addition to furnace breakdowns, there are two other major causes for poor heats. One is the quick heat single slag method, that is, no dephosphorizing slag is removed. The result is not only higher phosphorus content, but all foreign substances adhering to the scrap remain in the furnace to contaminate the finishing slag. At times this practice makes it impossible to obtain the proper conditions for finishing the heat, so that the steel is no better and may be worse than the better makes of open-hearth steels.

The second cause has several angles and is not so very easily controlled. It is ignorance of proper temperatures, not only for pouring but for certain reactions which, as is not generally recognized, cannot occur except within certain temperature ranges. The common failing of pouring at too high a temperature is little worse than working a heat at too low a temperature. This temperature phase is too large a one to be included here, but would be an excellent topic for a symposium.

An investigation of the two cases above and a number of other cases where electric steels have not lived up to their reputation reveals that the makers of these steels are low bidders in each case, and the price was about that of open-hearth alloy steel. What does this indicate? It looks as if electric steel manufacturers were willing to sacrifice quality to compete in price with open-hearth steel. This is not all; some companies have gone still further; they offer "electric steel made to open-hearth specifications" at the price of open-hearth steel and another grade known as electric steel made to electric specifications at an advance of 2c. per pound over the other price. Why should there be any call for such a policy?

PUBLIC EDUCATED TO NEED FOR HIGHER GRADE STEELS

The ~~steel-consuming pub~~lic has been educated to the need of higher grade steels during the war. The electric steel maker should continue to cultivate this good seed, instead of choking it off by prejudices born of this price-cutting policy. He should remember that when the price of open-hearth steel advanced from 250 per cent to 400 per cent, the price of his own product in a very few cases advanced as much as 100 per cent in spite of the higher cost of power, labor and raw materials. Only a part of his raw materials have dropped in price, while labor and power are still advancing. Even during the artificial process of price-setting lately foisted upon the steel industry, no definite price has been set on electric quality steel, and why should the manufacturers themselves start a campaign of cutting prices, and worst of all, cutting quality?

If the electric steel producer is an intelligent business man, he must realize that one ton of carelessly made steel may curtail more sales of electric steel than he could obtain by cutting his price to below his cost. The public soon forgets the many good shipments he has made, but one bad lot of steel leaves a bad taste, which salesmanship of the higher caliber may slightly sweeten but can never completely eradicate.

An awful epidemic of poor steel has existed since the signing of the armistice, probably due to a letting down after-war tension. This applies to all grades and makes of steel, but, as before mentioned, electric steel of late has not been all that it might be. Unfortunately, a large number of steel users are not equipped to thoroughly investigate a shipment of steel before putting it into work. They often spend more than the cost of the steel in forging, treating or machining before the fact is discovered that the material is defective. Of course the maker replaces the steel, but he does not repay the user for the work he has done upon it nor for the delays due to replacement. A discriminating buyer could well afford to pay more for his steel if the maker was so sure of his product that he could guarantee not only replacement but guarantee the purchaser against any loss due to defective steel. Why not get the proper price and in turn give only the best that can be produced by the electric furnace?

Every man making electric steel, if he is a normal man, cannot help but develop a feeling of attachment for his furnace and for the industry. Let him do justice to himself and his business and at the same time give the electric furnace a square deal.

The James H. Herron Co.,
Cleveland, Ohio.

Swansea Iron Works to Adopt American Process

An American process for the sintering of fine ores and sulphide ores is about to be adopted by six iron and steel and zinc manufacturers in Swansea, Wales. A representative of a well-known American metallurgical company was recently in this district at the invitation of leading manufacturers, and placed orders with six concerns for his firm's patent machine for sintering ores. All metallurgical works using fine ores, such as iron, lead, zinc, and sulphide ores, can use this system of sintering, and it is to be expected that the future will find other local works introducing the same process. As Swansea is known as the metallurgical center of the United Kingdom and has sometimes even been called the world's center of metallurgy, great importance may be attached to this introduction of an American process for sintering. A German sintering apparatus recently adopted by a large iron and steel plant in Swansea has not been wholly satisfactory.

Tentative Regulations for the Storage and Use of Fuel Oil

Specifications of Equipment Construction: Underground, Exterior and Interior Tanks, Piping, Heating, Combustion and Feeding—150-Deg. Flash Point Regulation—Limit of Heating 40 Deg. Below Flash—Embankment Dikes—Objections and Discussion

THE Committee on Inflammable Liquids of the National Fire Protection Association at a meeting in New York, Oct. 30-31, drew up the following regulations:

Oil-burning equipments are those using only liquids having a flash point above 150 deg. F., closed cup tester. Oil-burning equipments shall be operated only when a competent attendant is constantly on the premises.

In determining the flash point, either the Elliott, Abel, Abel-Pensky or Tag Closed testers shall be used, but the Tag Closed tester (standardized by the United States Bureau of Standards) shall be authoritative in case of dispute. All tests shall be made in accordance with the methods of tests as adopted by the American Society for Testing Materials.

Storage tanks should be placed underground to obtain the greatest measure of safety. Where this cannot be done and tanks are necessarily located within the building, or above ground, such an arrangement is considered more hazardous.

Above-ground storage or supply tanks may be permitted only outside of closely built districts, or outside of fire limits.

CONSTRUCTION OF UNDERGROUND TANKS

1. *Materials of Construction.*—(*a*) Tanks shall be constructed of galvanized steel, basic open-hearth steel or wrought iron of a minimum gage (U. S. Standard) depending upon the capacity, as given in Tables I and II.

For liquids of 20 deg. Baumé and below, tanks may be of concrete.[1]

TABLE I.

Capacity (Gallons)	Minimum Thickness of Material
1 to 560	14 gage
561 to 1,100	12 gage
1,101 to 4,000	7 gage
4,001 to 10,500	1/4 inch
10,501 to 20,000	5/16 inch
20,001 to 30,000	3/8 inch

(*b*) In outlying districts to be prescribed by inspection departments having jurisdiction, tanks not exceeding 1100 gal. in capacity, if located 10 ft. or more from any building, may be constructed in accordance with Table II.

TABLE II.

Capacity (Gallons)	Minimum Thickness of Material
1 to 30	18 gage
31 to 350	16 gage
351 to 1,100	14 gage

2. *Joints and Connections.*—All joints shall be riveted and soldered, riveted and calked, brazed, welded or made by some equally satisfactory process. Tanks shall be tight and sufficiently strong to bear without injury the most severe strains to which they may be subjected in practice. Shells of tanks shall be properly reinforced where connections are made and all connections made through the top of tank above the liquid level.

3. *Rust Proofing.*—All tanks shall be thoroughly coated on the outside with tar, asphaltum or other suitable rust-resisting material, dependent upon the condition of soil in which they are placed. Where soil is impregnated with materials, tanks shall also be made of heavier metal.

4. *Venting of Tanks.*—(*a*) An independent, permanently open galvanized iron vent terminating outside of building shall be provided for every tank.

(*b*) Vent openings shall be screened (30 x 30 nickel mesh or its equivalent) and shall be of sufficient area to permit proper inflow of liquid during the filling operation and in no case less than 2 in. in diameter and accessible for examination and removal; shall be provided with weatherproof hoods and terminate 12 ft. above top of fill pipe, or if tight connection is made in filling line, to a point 1 ft. above the level of the top of the highest reservoir from which the tanks may be filled and never within less than 3 ft. measured horizontally and vertically, from any window or other building opening.

Tanks of 500 gal. capacity or less may be provided with a combination fill and vent fitting so arranged that fill pipe cannot be opened without opening the vent pipe.

(*c*) Where a battery of tanks is installed, vent pipes may connect to a main header, but individual vent pipes shall be screened between tank and header. The header outlet shall conform to the foregoing requirements.

5. *Filling Pipe.*—Filling pipe shall be turned up so as to form a trap or seal and when installed in the vicinity of any door or other building opening, shall be as remote therefrom as possible, so as to prevent liability of flow of oil through building openings; terminal shall be outside of building in a tight, incombustible box or casting, so designed as to make access difficult by unauthorized persons.

6. *Manhole.*—Manhole covers shall be securely fastened in order to make access difficult by unauthorized persons. No manhole shall be used for filling purposes.

7. *Test Well of Gaging Device.*—See Par. 32.

8. *Setting of Tanks.*—(*a*) Tanks to be buried underground with top of the tanks not less than 3 ft. below the surface of the ground, and below the level of any piping to which the tanks may be connected, except that in lieu of the 3-ft. cover, tank may be buried 18 in. below the ground level and a cover of reinforced concrete at least 6 in. in thickness provided, which shall extend at least 1 ft. beyond the outline of tank in all directions; concrete slab to be set on a firm, well-tamped earth foundation. Tanks shall be securely anchored or weighted in place to prevent floating.

Where a tank cannot be entirely buried, it shall be covered over with earth to a depth of at least 3 ft.

---

[1] Investigations are under way to determine the advisability of permitting the use of concrete tanks for oils above 20 deg. Baumé.

and sloped on all sides, slopes not to be less than 3 to 1. Such cases shall also be subject to such other requirements as may be deemed necessary by the inspection department having jurisdiction. If tank cannot be set below the level of all piping to which it is connected, satisfactory arrangements shall be provided to prevent siphoning or gravity flow in case of accident to the piping.

(*b*) Tanks shall be set on a firm foundation and surrounded with soft earth or sand well tamped in place, or incased in concrete as outlined in Section 14 (*b*).

(*c*) When located underneath a building the tanks shall be buried with top of tanks not less than 2 ft. below the level of the floor. The floor immediately above the tanks shall be of reinforced concrete at least 9 in. in thickness, extending at least 1 ft. beyond the outline of tanks in all directions, and provided with ample means of support independent of any tank.

ABOVE-GROUND TANKS

9. *Materials of Construction.*—(*a*) Tanks, including top, shall be constructed of galvanized steel, basic open-hearth steel or wrought iron of a minimum gage (U. S. Standard) as specified in Tables III to VII, inclusive. No open tanks shall be used. (*b*) For liquids under 20 deg. Baumé, tanks may be of concrete.

TABLE III.

Horizontal or vertical tanks not over 1100-gal. capacity:

Capacity (Gallons)	Minimum Thickness of Material
1 to 30	18 gage
31 to 350	16 gage
351 to 1,100	14 gage

TABLE IV.

Horizontal tanks over 1100-gal. capacity:

Maximum Diameter	Minimum Thickness of Material Shell	Heads
Not over 5 feet	10 gage	7 gage
5 feet to 8 feet	7 gage	¼ inch
8 feet to 11 feet	¼ inch	5/16 inch

TABLE V.

Vertical tanks over 1100-gal. capacity. Under 40-ft. in diameter and containing not more than 5000 gal.:

Bottom No. 8 gage
Bottom Ring No. 8 gage
Other Rings No. 10 gage
Top No. 12 gage

TABLE VI.

Under 40 ft. in diameter and containing more than 5000 gal., but not more than 10,000 gal.:

Bottom No. 8 gage
Bottom Ring No. 7 gage
Other Rings No. 8 gage
Top No. 12 gage

TABLE VII.

Other vertical tanks to be of thickness not less than indicated in the following table, the figures referring to U. S. Standard gage:

Diameter, Ft.	Top	Top Ring	2nd Ring from Top	3rd Ring from Top	4th Ring from Top	5th Ring from Top	6th Ring from Top	Bottom
80	10	7	7	3	0	3–0	5–0	10
75	10	7	7	4	1	2–0	4–0	10
70	10	7	7	4	1	2–0	4–0	10
65	10	7	7	5	1	0	3–0	10
60	10	7	7	5	2	0	2–0	10
55	10	7	7	6	3	1	2–0	10
50	10	7	7	7	4	1	0	10
45	10	7	7	7	5	3	1	10
40 and less	10	7	7	7	5	3	2	10

(*c*) Tanks of capacity greater than given in Table VII shall be of material sufficient in thickness to hold the contents, with a proper factor of safety. (*d*) No vertical tanks shall exceed 35 ft. in height. (*e*) Riveted joints shall have an efficiency of at least 60 per cent. (*f*) The specifications for joints, connections and rust proofing shall be the same as those for underground tanks.

10. *Roofs or Tops.*—No wooden or loosely fitting metal roofs or tops shall be permitted. Roof or top shall be without unprotected openings; shall be firmly and permanently joined to the tank, and all joints made as noted previously for underground tanks.

11. *Venting of Tank.*—(*a*) A permanently open vent conforming to that described for underground tanks shall be provided. (*b*) Each above-ground tank, over 1000 gal. in capacity, shall have all manholes, vent openings, and other openings which may emit inflammable vapor provided with 30 x 30-mesh, non-corrodable wire screen, or its equivalent, so attached as to completely cover the opening and be protected against clogging. A safety relief of 1½ per cent of roof area shall be provided, or manhole covers of equal area must be kept closed by weight only, and not firmly attached. The screen on such opening may be made removable, but shall be kept normally firmly attached and shall be accessible for inspection.

12. *Setting of Tanks.*—Tanks with bottom more than 1 ft. above the ground shall have firm foundation and supports of incombustible materials, except wooden cushions. The storage of combustible material within 10 ft. of any tank is prohibited.

13. *Protection Against Lightning.*—Metal tanks shall be constructed entirely of metal including top, side and bottom; all openings shall be hermetically sealed (See Caulking of Joints), except breather vent, which shall be screened. All tanks shall be electrically grounded, by resting directly on moist earth or grounded in accordance with the requirements for lightning protection of the National Fire Protection Association. All steel work of reinforced concrete tanks shall be interconnected and grounded by an approved method.

14. *Embankments and Dikes.*—(*a*) In locations where above-ground tanks are liable, in case of breakage or overflow, to endanger surrounding property, each tank shall be protected by an embankment or dike. Such protection shall have a capacity of not less than one and one-half times the capacity of the tank surrounded, and to be at least 4 ft. high, but in no case higher than one-fourth the height of tank when height of tank exceeds 16 feet.

(*b*) Embankments or dikes to be made of earthwork or reinforced concrete. Earthwork embankments to be firmly and compactly built of good earth from which stones, vegetable matter, etc., have been removed, and to have a flat section at top of not less than 3 ft. and a slope of at least 2 to 1 on both sides

(*c*) Embankments or dikes shall be continuous, with no openings for piping or roadways. Piping shall preferably be laid over or under embankments; if it is necessary to install pipes through embankments concrete wing walls shall be provided. Brick or concrete steps shall be used where it is necessary to pass over.

TANKS INSIDE BUILDINGS

Inside storage is regarded as much more hazardous than outside storage. Where used the following requirements shall be rigidly applied:

15. *Setting and Heat Insulation of Tanks.*—(*a*) Tanks shall not be located above the lowest story, cellar or basement of building.

(*b*) Tanks shall be located below the level of any piping to which they may be connected, or if this is impracticable, satisfactory arrangements shall be made to prevent siphoning or gravity flow in case of accident to the equipment or piping.

(*c*) Tanks shall be set on a firm foundation and those exceeding 2500-gal. capacity shall be supported independently of the floor construction.

(*d*) Steel tanks shall be completely enclosed with a heat insulation of reinforced concrete not less than 12 in. in thickness, with at least a 6-in. space on sides between tank and concrete insulation filled with sand or well tamped earth, and with 12 in. of sand on top of tank, either between tank and concrete slab or above concrete slab.

(*e*) Concrete tanks shall be completely enclosed with a heat insulation of reinforced concrete not less than 8 in. in thickness, with at least a 6-in. space on sides between tank and concrete insulation filled with sand, or well tamped earth, except that for top of tank an insulation of 12 in. of sand without concrete covering shall be deemed sufficient.

(*f*) Walls of concrete tanks shall be constructed independently of and not in contact with the building walls.

16. Vents shall be installed as previously described.

LOCATION AND CAPACITY OF TANKS FOR UNDERGROUND STORAGE

17. Tanks shall preferably be located at least 50 ft. from important buildings. When this cannot be done, the limit of individual tank capacity permitted shall be dependent on the location of tanks with respect to adjacent buildings, as follows:

(*a*) Tanks may be of unlimited capacity if buried underneath or lower than any floor or pit of any building within 50 ft. radius of the tank. (*b*) Where a building having a floor or pit lower than the tank is within 40 ft. radius, the capacity of the tank must not exceed 500,000 gal. (*c*) Where a building having a floor or pit lower than the tank is within 30 ft. radius, the capacity of the tank must not exceed 200,000 gal. (*d*) Where a building having a floor or pit lower than the tank is within 25 ft. radius, the capacity of the tank must not exceed 150,000 gal. (*e*) Where a building having a floor or pit lower than the tank is within 20 ft. radius, the capacity of the tank must not exceed 100,000 gal. (*f*) Where a building having a floor or pit lower than the tank is within 10 ft. radius, the capacity of the tank must not exceed 75,000 gal. (*g*) If tank is within 10 ft. of any building, and the top of the tank is above the lowest floor or pit of the building, the tank shall not exceed a capacity of 50,000 gal., and must be of metal entirely enclosed in concrete.

ABOVE-GROUND STORAGE

18. (*a*) The relation between capacity of individual tanks and the permissible distance from other property is shown in Table VIII.

(*b*) For tanks of 400,000-gal. capacity or greater, a minimum distance of 175 ft. to adjoining property or nearest building may be permitted, provided that an approved type of extinguishing system is installed for the tank and covering other parts of the yard or system.

(*c*) For tanks permitted from 50 ft. and up to 175 ft. of building or property line, the capacity may be increased 33 per cent if the tank is provided with an approved extinguishing system.

19. *High Water.*—Tanks shall be so located as to avoid possible danger from high water.

20. *Streams Without Tide.*—When tanks are located on a stream without tide, they shall, where possible, be down stream from burnable property.

21. *Tide Water.*—On tide water, tanks shall be located, if practicable, well away from shipping districts.

STORAGE INSIDE OF BUILDINGS

22. *Permanently Set Storage Tanks Inside Buildings.*—(*a*) In ordinary buildings the gross capacity of tanks shall not exceed 5000 gal. (*b*) In fire-resistive buildings the gross capacity of tanks shall not exceed 10,000 gal. (*c*) In any building, if in a fire-resistive or detached room cut off vertically and horizontally in an approved manner from other floors of the main building, the gross capacity of tanks shall not exceed 50,000 gal., with an individual tank capacity not exceeding 25,000 gal., provided the insulating sand specified under setting and heat insulation of tanks shall be increased to 12 in. on sides and 18 in. on top.

TABLE VIII.

Capacity of Tanks, Gallons	Minimum Distance to Line of Adjoining Property or Nearest Building (Feet)
750	5
1,500	10
3,000 or less	20
21,000 or less	25
31,000 or less	30
45,000 or less	40
64,000 or less	50
80,000 or less	60
128,000 or less	75
200,000 or less	85
266,000 or less	100
400,000 or less	150
666,000 or less	250
1,333,000 or less	300
2,666,000 or less	350

PIPING—GENERAL REQUIREMENTS

23. *Cross-Connections.*—Cross-connections permitting gravity flow from one tank to another except through open connections shall be prohibited. This shall not be construed as prohibiting properly gated connections through subdivisions in any individual tank.

24. *Workmanship.*—All pipe connections to tanks and other oil containing or using devices, shall be made in a substantial, workmanlike manner.

25. *Type of Material.*—All piping shall be of the standard full weight wrought iron or steel type for working pressures less than 100 lb.; for working pressures in excess of 100 lb., extra heavy pipe and fittings shall be used. No pipe less than ½ in. internal diameter will be permitted.

26. *Installation.*—Piping shall be run as directly without sags, and so laid that where possible pipes pitch toward the supply tank without traps; provision shall be made for expansion, contraction, jarring and vibration.

27. *Tests.*—Piping for systems with working pressures under 100 lb. after installation shall be tested and proved tight at a pressure of not less than 150 lb.; where working pressures exceed 100 lb., piping shall be tested and proved tight at a prsssure 50 per cent in excess of the working pressure.

28. *Unions.*—Union, if used in place of right and left couplings, shall be of an approved type.

29. *Protection to Piping.*—(*a*) Piping between any separated oil containing or using parts of the equipment shall be as far as practicable laid outside of the building underground, and properly protected against corrosive action; if necessarily inside it shall preferably be laid in a trench with proper metal cover; if on floor or subject to mechanical injury it shall be protected.

(*b*) Pipes leading to the surface of the ground or above the floor, particularly risers to furnaces, shall be cased or jacketed when necessary to prevent loosening or breakage.

(*c*) Fill and vent pipes shall be protected in a substantial manner against mechanical injury.

30. *Outside Piping.*—(*a*) All outside piping shall be laid in solid earth, or in a trench. Oil pipes shall not be located near, nor in the same trench with other piping, excepting steam lines for heating. Propping the pipes on wooden blocks shall be avoided. (*b*) Openings for pipe through outside walls below the ground level shall be made oil-tight and securely packed with flexible material.

31. *Valves.*—(*a*) All valves shall be of an approved type. (*b*) Shut-off valves shall be provided on both sides of any strainer which may be installed in pipe lines; in discharge and suction lines to pumps; in discharge and return lines to any tank, as near as practicable, and in branch lines near burners. (*c*) A check valve of an approved type shall be installed in each air line near the burner. (*d*) A pressure relief valve shall be installed in supply lines to burners and so arranged as to return surplus oil to supply tank. (*e*) The use of automatic shut-off valves for the oil supply is recommended.

32. *Oil Level Indicating Device.*—A test well or gaging device shall be installed, and so designed as to prevent the escape of oil or vapor within the building at any time. Top of well shall be sealed and, where located outside of building, kept locked when not in use.

33. *Strainers.*—Suitable strainers shall be installed in the suction line. Large basket strainers are recommended in the receiving or filling line of storage tank to remove dirt and foreign matter.

HEATING

34. *Heating of Tanks.*—(*a*) Where it is necessary to heat oil in storage tanks in order to handle it, the oil shall not be heated to a temperature higher than 40 deg. F. below the flash point, closed cup. (*b*) Heating shall be done by means of properly installed coils within the tank, using only steam or water. Thermostatic control and thermometer shall be provided for all heating devices.

35. *Heaters, Other Than Those for Tanks.*—(*a*) Heaters shall be of substantial construction; all joints shall be made oil-tight. (*b*) Only steam or water shall be used for heating. (*c*) Heater shall be by-passed so that in warm weather it will not be under constant pressure while not in use.

FUEL OIL BURNERS

36. (*a*) The burner mechanism shall be so designed as to not enlarge the orifice, and so that the needle valve cannot be unscrewed and removed in operating.

PUMPING SYSTEMS

37. Oil shall be pumped from tank to burners. Systems where burners are supplied by gravity, or pressure on tanks are prohibited.

38. *Pumps.*—(*a*) Pumps shall be in duplicate, of an approved design, and secure against leaks. (*b*) They shall be located in a room cut off from oil-burning devices and provided with entrance which can be reached without passing through room where burners are located; if this is not practicable, provision shall be made for remote control. (*c*) Pumps used in connection with the supply and discharge of storage tanks shall be located outside the tank or embankment walls, and at such a point that they will be accessible at all times, even if the oil in the tank or reservoir should be on fire.

OBJECTIONS TO THE REGULATIONS

The following are the objections that have so far come to the attention of the American Petroleum Institute.

In commenting on these criticisms, the Institute desires that the reasons for asking for any changes should be clearly stated, as it is concerned with both the practical side of the question and the economic effect these regulations are likely to have.

Flash Point 150 Deg. F.—This is too high, and while not necessarily arrived at in consideration of the U. S. Navy fuel oil specifications, where altogether different conditions are met with, the effect is the same. In oil fields and in many industrial establishments where fuel oil has been in constant use for a great many years oils of a much lower flash point have been used without accident and fire arising from the point of flash. It is clear that oil having a flash point of 100 deg. F. is safer than an oil that flashes at 30 deg. F.; but above atmospheric temperature, for storage purposes an oil that flashes at 200 deg. F. is no more dangerous than that which flashes at 600 deg. F. In the same sense, if an oil is well above atmospheric temperature, it is just as safe with its flash point at say 135 deg. F. as it would be at 150 deg. F. The flash point of oils is most generally accepted as the index of the fire hazard because it is not until the oil has been heated to its ignition temperature (i.e., fire point) that explosion takes place in the body of the oil. Oil cannot ignite at the temperature of its flash point, and therefore, if suitable provision for venting is made, such small volumes of gases as may be given off before the oil reaches the temperature of its fire point should vent themselves, and cannot cause a conflagration of the oil in the tank. A tank that is not a still and from which combustible material is kept is perfectly safe. A flash point of 135 deg. F. has been suggested, which for all practical purposes is contended to be as safe as 150 deg. F., and is a great deal easier to be met with by fuel oil producers all over the country. To set 150 deg. F. as the minimum flash point is to exclude oils of lower flash, and we are desirous of knowing just what effect this would have upon the industry.

Par. 1 (*a*).—Question has arisen as to whether there is preference for the use of the Birmingham gage over that of the U. S. Standard. Galvanized steel would be unnecessarily expensive, since fuel oil would not have a corrosive action upon ungalvanized steel, and painting of tanks should afford every protection for exterior.

Par. 2. "All connections made through top of tank above liquid level."—Bottom connections from storage tanks should be permitted. The statement of the chairman of the Committee on Inflammable Liquids that permission may be secured for such bottom connections is not in itself sufficient and the regulations should properly provide for this. It is argued that it is impossible to empty tanks over 12 to 15 ft. in height from connections made from top above the liquid level.

Par. 9.—Provision should be made that rectangular be rewritten and the burying of tanks be reduced to less than 3 ft. where there is no live load. It is also suggested that a tank may be buried 12 in. below the ground level instead of 18 inches.

Par. 9.—Provision should be made that rectangular tanks of suitable strength shall be permitted.

Par. 9 (*a*).—Change U. S. Standard to Birmingham. See also Par. 1 (*a*).

Tables III to VII.—A large refiner states that "regulations should permit the use of metal tanks without limits to dimensions so long as an established factor of safety is observed. Therefore we recommend that all dimensions of tanks be eliminated."

Par. 9 (*d*).—Some vertical tanks are 48 ft. high. If you have any objection to 35 ft. we would like to know what has been your experience in this respect and what you would suggest as practicable.

Par. 9 (*e*).—It has been suggested that 60 per cent be changed to 50 per cent and that the following be added: "but a less efficiency will be allowed if the factor of safety of the tank is 3 to 6."

Par. 10. "Roof of top....... shall be firmly and permanently joined to the tank."—If anything goes wrong the roofs cannot be lifted. It should be noted in this paragraph in connection with paragraph 2 that bottom connections including bleeders are not permitted.

Par. 14.—Embankments or dikes are without doubt advisable where crude oil is stored, but it has not been the practice in many quarters to provide them for tanks holding fuel oil distillates. This provision would not necessarily insure protection, since they would become filled with rain and the water become stagnant, polluted, prejudical to health, and a breeding place of mosquitoes, while if free of water in time of fire they would soon become filled with water that may be used in extinguishing fire. Moreover, these dikes, if not filled with water, would be in the nature of "catch-alls" for waste paper, etc. If you think this provision will prove an unnecessary burden it would be advisable to state what has been the general practice in this respect.

Specifications for Concrete Tanks.—This section has been set aside pending the outcome of the test to be conducted by the Committee on Concrete Tanks of the American Concrete Institute, which will probably cover a period of two months. The results of these tests are to be submitted before the convention of the American Concrete Institute to be held in Chicago next February, but without doubt the National Fire Protection Association will be guided by these tests in fixing specifications upon concrete tanks before that time.

Moreover, the provision that "for liquids of 20 deg. Baumé and below tanks may be of concrete"—Par. 1 (*a*) and 9 (*b*)—should also be set aside until the tests have been completed. It is well known that oils of lighter gravity than 20 deg. Baumé have been stored successfully in concrete tanks.

Pars. 17 and 18.—It is contended that distance of tanks from buildings cannot be economically determined by a set rule, as hazards and practicability of each location must have special consideration.

Par. 22.—It is the practice to maintain on hand 14 days' supply of coal. Office buildings are now using as much as 4000 to 5000 gal. of fuel oil daily, and it is necessary that as much as from 40,000 to 50,000 gal. be kept in storage during cold weather. If tanks are properly designed and built, is there any particular reason why special provisions should be made for special fire-resistive rooms when as much as 50,000 gal. are to be kept in storage? What has been the general practice?

Par. 34 (*a*).—This provision has the effect of stating that the flash point is not a measure of the hazard, and seems unduly severe, for in practice fuel oil in storage is frequently heated to a temperature higher than 40 deg. below its flash point.

Par. 38 (*a*).—This has been much disputed. It does not give consideration to those smaller installations where the duplicate pump is not only economically a burden but is unnecessary because cessation in operation permits time for cleaning and repairing.

Par. 38 (*b*).—This paragraph requiring pumps to be located in a room cut off from oil-burning devices has been strongly objected to. What is your attitude toward this provision?

Great Future Predicted for the Anhinga Fiber Industry

The plant known as anhinga is a native of the State of Para, Brazil, and it is declared that this State alone is capable of producing 100,000 tons annually for export.

The anhinga constitutes the raw material from which cellulose for the manufacture of linen paper is obtained. The fibers may also be transformed by a chemical process into an artificial cotton fiber. The fact that this fiber does not decay gives it an advantage over that obtained from analagous plants. The anhinga grows along the banks of all the rivers of Para, which have a slow current, permitting a soft bed of mud for their roots. In 1908 the Commercial Association of Para received a letter from a paper factory as to the possibilities of obtaining this fiber in large quantities, but at the time the association was unable to find anyone to exploit the industry, because of the large and easily acquired profits afforded by the rubber industry. However, experiments were made last year with excellent results, and those interested in the new industry have recommended that abandoned sugar mills be fitted up for the treatment of the fiber. A mill already in operation is producing 600 kilos daily. The price of the fiber at Para is 300 to 350 reis per kilo. It is stated that the head of the Para State Chemical Laboratory has discovered a new process for dissolving the fibers, transforming them into very fine, white fibers, like cotton fiber of prime quality. Moreover their structure is superior to that of the cotton fiber, since the lines are straight and parallel.

The Chemical Industry in China

Ho Hsin Smelting Works, capitalized at approximately $550,000, has commenced operations at Pootung and aims to become one of the leading steel works in China. Its daily output at the time of the latest available report was 10 tons of pig iron. When the plant is completed the output will be 40 tons daily.

Under the direction of Japanese chemists certain chemical products such as caustic soda, creosin, stearin and soaps have been manufactured in Kwantung during the war. The raw materials were brought from Manchuria.

A committee of chemical investigation reports that there is in Manchuria a great abundance of raw materials suitable for use in the chemical industry, awaiting only active participation of capital to yield large returns.

More than 20 cotton spinning and weaving mills are now being operated at Shanghai. British, Japanese and Chinese interests are predominant. Large tracts of land at Yangtzepoo and Pootung have been purchased by Japanese interests and extensive mills are being erected. It is reported also that a number of modern office buildings requiring building materials of many types are about to be erected in Shanghai.

Patent Rights and Remedies

By Chesla C. Sherlock

BEFORE a patentee can seek damages for an infringement of his patent or invention, he must know just what his rights are under the law and what constitutes an infringement.

It is not necessary, for a patent right to be violated, for the infringing device to be identical with the patented article in form and appearance. A long line of cases holds to the view that proof of adoption of the substance of the patent is sufficient to show infringement.

"In one sense," said Mr. Justice Brown, "it may be said that no device can be adjudged an infringement that does not substantially correspond with the patent. But another construction, which would limit these words to the exact mechanism described in the patent, would be so obviously unjust that no court could be expected to adopt it."

However, there are upwards of fifty cases decided by the United States courts in which it is held that the patentee is to be protected only in respect to the precise device which he has claimed and described in his patent. And another long line of cases is authority for the statement that a machine or process which is substantially different is no infringement.

What Is an Infringement?

In Winana v. Denmead, 14 U. S. (L. ed.), 717, and Werner v. King, 96 U. S., 218, it was held that "when form and substance are inseparable, it is enough to look at the form only. When they are separable, where the whole substance of the invention may be copied in a different form, it is said to be the duty of the courts to look through the form for the substance of the invention—for that which entitled the inventor to his patent, and which the patent was designed to secure; where that is found it is an infringement; and it is not a defense that it is embodied in a form not described and in terms claimed by the patentee."

Nor will the law permit the infringer to escape punishment where he has adopted a substantial equivalent of the patented article, for the substantial equivalent of a thing, in the sense of the patent law, is the same as the thing itself; so that if two devices do the same work, in substantially the same way, and accomplish substantially the same result, they are the same even though they differ in name, form and shape.

How Patentee May Assert Rights

Having this brief statement of what will ordinarily amount to infringement, we are now able to pass on to a consideration of the more important phase of the subject, namely, the manner in which the patentee or those holding under him may assert their rights under the patent.

In the first place, it must be kept in mind that the inventor has no exclusive right to his invention until he has acquired a patent. It is the patent that conveys these rights and not the invention, and no suit can be maintained without such patent.

The very first obligation on the part of one bringing a suit for infringement of a patent is that he must allege that he is the original inventor and patentee, or that he holds under a patent so taken out. This does not mean that in the absence of a patent an inventor has no rights in his invention, but it simply means that the rights hereinafter mentioned do not belong to any but those who may show that they hold under a patent. The inventor certainly has a property right in his invention, and this property right will be enforced by a court of equity.

The suit must be brought in the name of all parties interested in the patent at the time it was infringed, whether the patentee, assignee, grantee, or all of them jointly.

It is essential, in order to assert the rights under a patent, to mark the patented article with the date thereof, and where this is impracticable to note it on the wrapper or carton. It is also necessary to give notice to the infringer that he has infringed the patented device, and it has been held that neglect to place the date of the patent on the article will not defeat the rights of the patentee provided he has given notice of infringement to the infringer, as it accomplishes the same result.

As to how the infringement is determined by the courts and juries, there are many rules and practices. In the case of machinery, for instance, the two machines are set up side by side and the question is determined by comparison. The burden of proof is upon the plaintiff or patentee, unless the defendant specifically admits that he has infringed the patented article.

Rule on Recovery of Damages

As a rule, the patentee is entitled to recover such damages as he may show that he is entitled to. There has been a great deal of discussion as to whether royalties on the infringing article made and sold were not the proper basis of damage for the patentee.

Mr. Justice Field has said: "In order that a royalty may be accepted as a measure for damages against an infringer who is a stranger to the license establishing it, it must be paid or secured before the infringement complained of; it must be paid by such a number of persons as to indicate a general acquiescence in its reasonableness by those who have occasion to use the invention; and it must be uniform at all places where the licenses are issued."

Where the patent has been infringed before a royalty has been established, the patentee may show what a reasonable royalty would have been and, upon such showing, use it for a measure of damages against the infringer.

It is also a right of the patentee, upon a showing of infringement, to have an accounting of the business done by the infringer, especially an accounting of the profits of the infringing device, and, upon a showing of them, recover all of the profit made by the infringing device.

However, he cannot hold the infringer for profits which were not made, and in this case his remedy is for damages in such amount as he is able to set up and recover.

We have found, then, that a substantial infringement of the patented device is sufficient to constitute infringement in the sense of the patent law, and that the patentee may recover profits, if there have been any; or damages, or a royalty on the articles manufactured, and where no royalty was established, a reasonable royalty on the device.

Phosphatic Coatings for Rust Proofing Iron and Steel

BY L. E. ECKELMANN

AMONG the most successful and comparatively recent developments in the non-electrolytic rust proofing of iron and steel is that employing phosphatic iron as a protective coating. All of the older processes of rust prevention, such as the Browning, Bower-Barff and others similar in principle, though giving moderately good coatings and, in the case of the Browning method, beautifully colored and lasting finishes, were uneconomical of time, expenditure of heat, and in some cases required a multiplicity of operations. The personal skill and experience of the operator were also most important factors in many of these processes where high temperatures, muffles and combinations of fused salts were used.

Recent phosphatic rust proofing differs from other methods in that the dimensions or sharpness of finely machined edges and surfaces of the articles are not appreciably altered. Due to the low temperatures used, the physical properties of tempered steel are in no way affected, and magnets so treated retain their magnetic force. Even very fine springs do not have their elasticity impaired. Fig. 1 is an illustration showing the remarkable adhesion or molecular bonding of the phosphatic coatings. On the other hand, dental needles having points so fine (0.003 in.) that a slight corrosion ruins them completely, are successfully protected by phosphatic coatings without injuring the elasticity of the needles or affecting the delicate barbs covering their surfaces.

COSLETT'S PROCESS

Rust proofing is effected simply by immersion of the clean objects in a hot solution for periods of one to three hours. The deposition of the coating depends upon the action of a solution of iron phosphates in weak H_3PO_4 on a metallic base, such as iron. Phosphoric acid solutions will dissolve ferrous phosphate within certain limits in direct proportion to the concentration of the acid present. If any base or metal be added—for example, iron—capable of entering into combination with the free acid present in such a solution, the formation of ferrous phosphate on the metallic surfaces will precipitate this salt back on the iron at the point of solution. The already saturated condition of the iron phosphate solution will naturally aid the precipitation when more of this compound is formed. The action proceeds with the evolution of hydrogen until no more elemental iron is exposed, the article being then completely coated with a basic iron phosphate.

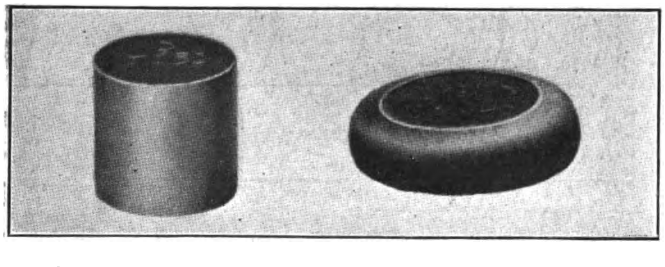


FIG. 1. PHOSPHORIC COATING IS NOT SPLIT OFF BY LARGE DEFORMATION

(On left—Before compression. On right—After compression. Both actual size)

This reaction was the basis of the process developed by Coslett in 1907, its later commercial adaptation operating as follows: Ferrous phosphate made by mixing iron filings with concentrated H_3PO_4 sufficient to form a semi-fluid paste was added to weak boiling phosphoric acid. Iron or steel articles were immersed in this boiling solution for three or four hours, and when removed were covered with a rust-resisting light gray deposit of basic ferrous phosphate. The difficulty of obtaining uniform coatings, the great amount of suspended salt adhering to the work—in some cases incorporating itself with the actual coating and increasing the dimensions of the articles—the consequent necessity of rinsing the work after treatment, and the non-uniformity of the finish, all contributed to the slow adaptation of this process until these troublesome features could be eliminated.

PARKERIZING

Messrs. Allen and Richards were mainly responsible for changes in the Coslett process, which made its present modification one of the most simple methods of rust prevention. Their patented modification in use today is known as "Parkerizing." The old Coslett solution was modified by the addition of an oxidizing agent such as MnO_2 to a 0.75 per cent solution of H_3PO_4 containing ferrous phosphate, this salt being partly oxidized to the ferric state after continued agitation and boiling. This last action is necessary to complete the partial oxidation of the ferrous salt, the correct proportion between the phosphates being 3 ferrous to 1 ferric. The formation of the coating, a basic ferroso-ferric phosphate, is similar in action to the Coslett reaction mentioned above. It has been found lately that part of the MnO_2 may be replaced by air, also that in the latter case the action of the MnO_2 can be considered as partly catalytic.[1] In the latter method of oxidation, the method of aëration presents a practical problem, since the finish of the work will be affected if the objects processed are of complicated form, and air be trapped and held in contact at any point.

NATURE OF COATING

The coating on iron or steel articles after removal from this phosphoric solution is of a uniform dark gray color, varying in intensity of shade according to the surfacing treatment the articles had previously received. In common with all chemical methods for metal coloring, the shadings obtained with phosphatic coatings are dependent on the previous treatment of the metal surfaces, such as sand blasting, tumbling, rubbing, etc. The choice of pickling solutions is also quite important. It is very interesting to note that while both the ferrous and ferric phosphates are light colored salts, the resulting ferroso-ferric phosphate is grayish black. There does not seem to be any definite formula for this compound; it may also be considered a mixture of basic phosphates. During the oxidation MnO_2 will break down to manganese phosphate, which also possesses rust-proofing qualities.

Processed materials, when dry, are dipped in a paraffine oil mixture, this treatment changing the dark gray coating to a deep black.

Phosphatic rust proofing is particularly adapted for the treatment of tools, typewriter parts, ordnance, motor parts, in fact for many things where rust should be prevented and an attractive finish is desired. In submarine mine cases used during the war, it was found that barnacles would not adhere to them when previously rust proofed by the above methods. Articles can be processed partly assembled, as the size of the parts will not be affected. Another peculiar phenomenon exhibited by the phosphatic coatings is the stoppage or filling of pores in defective castings, the sealing of these fissures holding even when subjected to considerable pressure.

---

[1] See U. S. Pat. No. 1,248,053.

Equipment of Rust-Proofing Unit

The main equipment of a moderate-sized unit consists of one 1000-gal. air jacketed, steam-heated, welded tank, four 450-gal. wooden tanks, a sand tumbler, boiler, and oil draining pans. The four wooden tanks are arranged in line, somewhat as shown in Figs. 2 and 3, two being heated with steam coils, and the other two are used for rinsing with jets. These tanks contain the following solutions in the order named: Caustic cleaner, rinse, pickle, rinse. The steam inlets in the two rinsing tanks provide the circulation by condensation, outlets being at the top. A 30-hp. boiler should give sufficient steam without need of preheating the feed water.

It is important, when planning, to arrange the cleaning and processing tanks, sand tumblers and other units in routine order. An overhead track passing over the different tanks is necessary, preferably extended at the ends to stack accumulated work. The writer advises the use of a double set of chain hoists. This will facilitate the rapid transference of work, which is carried in this case in steel baskets containing perhaps 450 assembled metal stampings, weighing about 375 pounds. Transference work from wooden pickling baskets to steel ones for the acid dip could in certain cases be eliminated by using lead- or tin-coated steel baskets.

Concentrated H_3PO_4 solutions of ferrous phosphate, powdered MnO_2, the ordinary pickling acids, soda, potash, oil- and grease-removing cleaners, and dipping oil are the only materials used. The processing acid is supplied by the licensors of the process.

Operation of Process

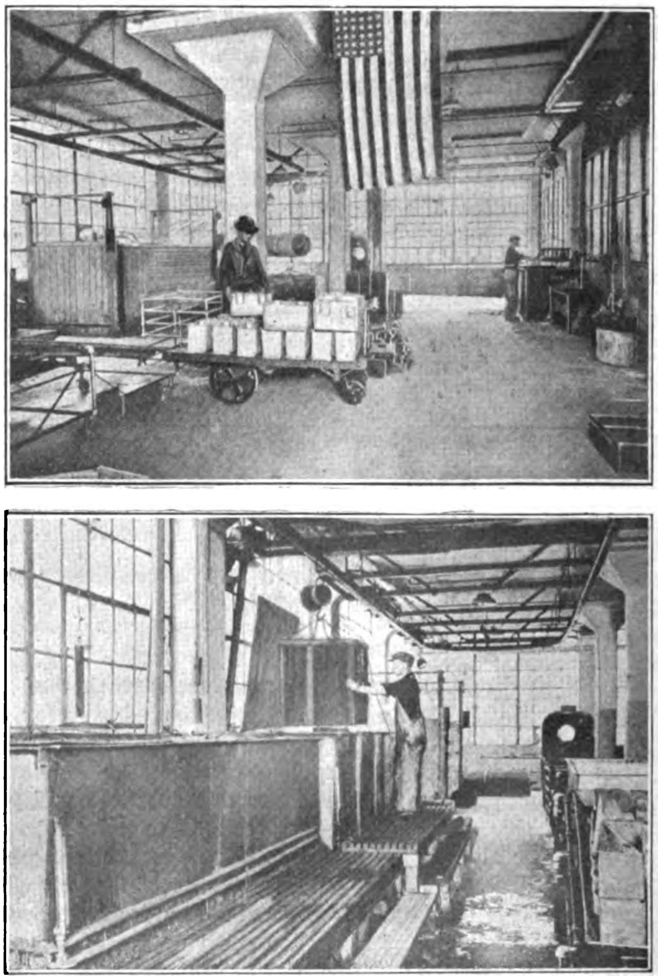
The iron or steel articles are freed from oil and grease by immersion for about twenty minutes in a solution of caustic soda or some patent cleaner—some of these cleaners easily removing mineral oils. Cleaning solutions should be over 200 deg. F. for best results. The work is now thoroughly rinsed in hot or boiling water, to dissolve any soaps formed in the cleaner, and when free of alkali passed into a 5 per cent H_2SO_4 pickle containing 1 oz. sodium bisulphite per gal. The decomposition of this salt will liberate SO_2 and if the pickling solution is kept below 150 deg. F., the SO_2 will be retained in sufficient quantity to act upon the work being cleaned. Black scale often present on iron, mainly Fe_3O_4, is quite insoluble, and can only be removed by excessive pickling, which is destructive to assembled or riveted work. The dissolved SO_2 will partly reduce the black scale to lower oxides, consequently facilitating solution and cleaning the metallic surfaces. When clean, which requires about 20 min., the work is again thoroughly rinsed in boiling water, to remove all acid and iron sulphates, then dried, sand tumbled or rubbed, and passed into the phosphate tank.

It is essential at this point that all articles be free from any adhering sulphates, as this radical is harmful to the phosphate solution. Some will always remain on the work, particularly when many parts are massed and treated together, and the last traces must be removed by rubbing or tumbling with sand. Sulphates not only affect the action of the rust-proofing solution but cause the formation of a rough, glistening coating. This is a coarse crystalline phosphate of iron, apparently growing from nuclei at points previously covered with sulphates. The size of the surface crystals seems to depend not only on the amount of metallic sulphate present, but upon unequal acidity over the surfaces of the object treated.

The writer has been able to eliminate the troublesome sanding operation in certain cases where the objects were of a shape permitting easy draining. After leaving the pickle the parts were immersed in limewater, and the precipitated calcium sulphate removed by agitation in a hot-water rinse. When this procedure is possible much time can be saved. It is a point where further development is possible, and a closer study of the effect of the different pickling acids on the processing solution and finish is necessary.

When metal is free from rust or scale, it can be sent to the phosphoric tank immediately after removing the grease and oil if a sand rub be substituted for the pickle. Clean, newly machined parts and stampings can be treated this way, the oil being removed with an organic solvent such as carbon tetrachloride. Unless the previous treatment of the steel or iron is known, this last procedure is not recommended.

When clean the work is transferred from the wooden crates used for pickling to steel baskets used in the rust-



FIGS. 2 AND 3. AN INSTALLATION OF 10-TON DAILY CAPACITY

proofing bath. When the sulphates are removed by lime-water the time consumed in transferring the articles can be saved by using lead coated baskets of the largest possible mesh.

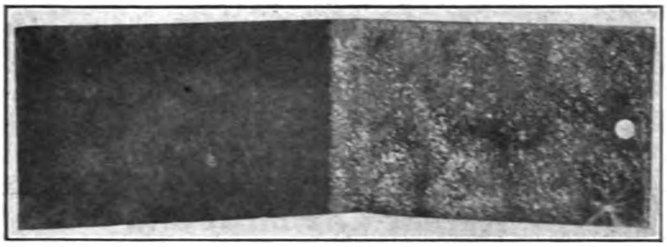


FIG. 4. EXPOSURE TEST OF SHEET PARTLY COVERED WITH PHOSPHATIC COVERING

Processing solution is made by mixing the phosphoric acid-iron phosphate mixture (sold under the trade name "Hyroacid") and manganese dioxide in the proportions of 4 pints acid and 2 lb. MnO_2 to each gallon of water, thoroughly mixing and boiling. Prolonged boiling for 12 hours is necessary when the solution is first made up, to insure the correlation of the different variables, such as acidity, ferrous and ferric iron. Continuous circulation of the solution is effected by proper construction of the tank, which should be provided with side heating coils and deflection vanes. Sludge forming from MnO_2 after the tank has been in use for some time is prevented from coming in contact with the work by baffle plates placed a certain distance from the bottom of the tank.

The articles are immersed from one to two and a half hours at 210 to 212 deg. F. When the evolution of hydrogen has ceased, the work is removed, dried, dipped in a paraffine oil mixture, and set in racks or pans to drain. Between batches it is advisable to boil the solution for an hour or two, as this improves its action.

Care must be taken to place the work so that it presents the least resistance to the flow induced by the heating coils and vanes in the tank.

CHEMICAL CONTROL

Ten cc. of the rust-proofing solution should be equivalent to 14.5 cc. N/10 NaOH for good results. Acidity running up to 18 cc. N/10 NaOH is not harmful, but higher amounts will have a pickling action on the work.

Twenty-five cc. of the solution should contain from 0.0236 to 0.0335 g. ferrous iron, and from 0.0019 to 0.00559 ferric iron. This is titrated with N/10 $KMnO_4$ in the usual manner—for more accurate readings N/20 $KMnO_4$ should be used. Correct correlation of acidity, ferrous and ferric iron is essential, and must be closely watched and controlled.

For convenience in operation, the acidity of the rust-proofing bath is expressed in "points of strength," 1 cc. N/10 NaOH being taken as one point. The depletion of the solution after each batch of work is coated will vary slightly from one to two and one-half "points." Acid and MnO_2 are added, the amounts and proportions per gallon given above being equivalent to one point of strength.

RESULTS OF PHOSPHATIZING

Objects of iron and steel treated by the above process are very resistant to rust, withstanding exposure, saline atmospheres or laboratory fumes to a large degree, and testing very satisfactorily under the salt spray.[1] (See Fig. 4.)

Iron and steel protected with phosphatic coatings are not so resistant to wear and abuse as sherardized or galvanized metal. Surfacings composed mainly of Fe_3O_4 produced by the Bower-Barff and similar processes are more resistant to acids and bluer in color. However, phosphatic rust proofing is considerably cheaper than any other well known rust-proofing process in use to-day, the simplicity of treatment and uniformity being important factors in its favor.

New York, N. Y.

Synopsis of Recent Chemical and Metallurgical Literature

War-Time Ferrous Metallurgy in Germany.—In the *Iron and Coal Trades Review* for Sept. 12 and 19, 1919, are printed abstracts of reports of the Commission appointed to examine the iron and steel works in the war zone. They present a good review of the present status of the steel plants in Lorraine, Belgium, France, Luxemburg, and the occupied portions of Germany. A significant quotation regarding the metallurgical practice in the works under control of the Central Empires follows:

"A remarkable ingenuity was displayed in German works by the technical and engineering staffs in devising substitutes for materials which were unobtainable owing to war conditions. Thus the deficiency in manganese ores was partly made up by the use of low-grade manganese ores and old manganiferous slags. The slags from the Westphalian blast-furnaces contained as much as 14 per cent of manganese, a large part of which could be recovered by re-smelting. The process was wasteful of fuel, and would not be profitable in normal circumstances, but in the emergency which arose this source of manganese proved to be most valuable. Calcium carbide was also substituted in some cases for ferromanganese in the manufacture of steel. But no evidence was forthcoming of any important technical developments in iron- and steel-making during the war; nor did the Commission find evidence of any large extensions to works having been made. The production of iron and steel in Germany being largely in excess of normal requirements in peace time, there was a sufficiency of output to meet war demands without any great extensions, such as were necessary in England. Indeed, when war broke out, it was at first impossible to dispose of the whole German production of steel, and a number of furnaces were put out. At a later stage of the war, when the demand for munition steel became pressing, the then existing shortage of labor made it difficult to meet this demand by the ordinary methods, and the difficulty was met to a considerable extent by the melting down of scrap obtained in great quantity by breaking up machinery and plants in the Belgian and French areas under German occupation. The breaking up of valuable machinery and plants in Belgian and French works, however, served another purpose, namely, the removal of competition in the years immediately following the conclusion of peace; and that this was the main object aimed at was evidenced by the systematic way in which in most cases the most vital parts of the plant were selected for destruction, even when large quantities of easily accessible material were available in other parts of the works."

---

[1] General Electric Bulletin, No. 48,926.

Hydrogen in the Ozone Form.—Closely allied to the practical work which has been carried on during the last two years in the reduction of gases of the atmosphere, oxygen, nitrogen and helium, and the manufacture of hydrogen and ozone, the more recent research and study of Prof. GERALD L. WENDT, of Chicago University, on the ozone form of hydrogen proves most interesting. Detailed accounts of his research are printed in the *Proceedings* of the American Academy as well as those of the American Chemical Society. The following paragraphs cover a brief abstract of the more complete report.

It is believed that hydrogen atoms, although possessed of single valences, unite to form a molecule of a weight 3, with seemingly the same relation to the hydrogen molecule as ozone has to the oxygen molecule. The active qualities of this new form differ from those of atomic hydrogen.

This is without doubt the same gas discovered to be present in a hydrogen discharge tube by Sir J. J. Thompson in 1912 and called by him X_3. In his experiments he found it combined with oxygen under action of light, was destroyed by sparking with oxygen or heating with copper oxide. It stood high temperatures without disintegration. No new spectrum was obtained with it.

Dr. Wendt, working with William Duane,[1] in 1914, produced chemically active hydrogen with alpha rays from radium, accompanied by a distinct contraction of the gas. The new gas formed H_2S with sulphur; reduced neutral permanganate solution to give manganese dioxide precipitate; decolorized acid permanganate, giving a manganous salt; reduced arsenic to arsine and phosphorus to phosphine; and gave a yellow compound with metallic mercury, probably a hydride, which decomposed on heating. Separation by an electrostatic field, 1000 volts per cm., proved these activities were not due to charged molecules or ions. The active gas is unstable, breaking down to the inactive molecule in a few minutes. In a temperature of liquid air the activity is destroyed either by condensation or disintegration to ordinary H_2.

The recent work of Lind[2] and Usher,[3] the latter in Ramsay's laboratory, has confirmed that the molecule of this gas is larger than H_2. Langmuir[4] has prepared an active form of monatomic hydrogen which is distinct from H_3 in that it will not pass through a plug of glass wool, being strongly adsorbed, and in that it does not exist except at the very highest vacua. The ozone form will on the contrary pass through long layers of glass wool and exists for some time at atmospheric pressure.

J. J. Thompson[5] by photographic method and Dempster[6] by electrical measurement have both shown the presence of H_3 in a tube of H_2 under electric discharge at high vacuum, and at pressures of 0.05 mm. the latter has shown that H_3 predominates.

Dr. Wendt makes this ozone form of hydrogen by passing ordinary H_2 through a Geissler tube. The absence of hydrogen ions in the product is shown by passing through a sensitive emanation electroscope. This is done over a period of many hours where the instrument is sensitive to the detection of 10 to 12 curie of radium emanation, with ease, and no ions are evidenced.

The H_3 molecule is not in accordance with the present theories of valence, although it has been proved consistent with Bohr's model of the hydrogen atom. "Indeed," as Prof. Wendt says, "it is probably only the injunction due to the valence theory which has prevented the observation of this variety of hydrogen at a much earlier time than the present."

Recent Chemical and Metallurgical Patents

Australian Patents

Complete specifications of Australian patents may be ordered from the Government Printer, Melbourne, one shilling each.

Recovering Fats and Oils.—To recover fats and oils from trade waste liquors, the saponaceous products are broken up by chlorine without agitation, the fatty matter being liberated from the alkaline base. The liquors are allowed to settle and then removed to another tank, where chlorine is forced into the inflowing stream by means of a jet of compressed air. (Australian Patent 6886, A. J. DE BAEVE, New South Wales; April 15, 1919.)

Electrodeposition of Zinc.—To minimize the deleterious effect of small quantities of cobalt in a zinc sulphate electrolyte, glue is added to the liquid either before or after passing into the cells. (Australian Patent 7190, R. H. STEVENS; assigned to Electrolytic Zinc Co. of Australasia Proprietary, Ltd., Tasmania; May 6, 1919.)

Dissolving and Breaking Down Shellac.—To prepare a solution of shellac for stiffening felt hats and like purposes, 4 lb. of soda is dissolved in 4 gal. of water in a steam-jacketed pan, after which 5 lb. of resin and 20 lb. of shellac are successively added and the mixture is gently boiled for 2 or 3 hours. Six lb. of salt and 3 lb. of soda each dissolved in 3 gal. of water are then added to the mixture, which is finally boiled for 2 hours. This mixture may be broken down by slowly stirring in 8 or 10 gal. of cold water, and for treating soft felt hats 1 lb. of linseed oil is substituted for the resin, while for hard felt hats about 10 lb. of resin may be used. (Australian Patent 7624, T. MACKENZIE, South Australia; May 6, 1919.)

Liquid Fuel.—To manufacture a liquid fuel which is suitable for internal combustion engines, alcohol is partially etherealized by making it bubble, at a temperature of distillation of 100 to 150 deg. C., through a mixture consisting of 9 parts of sulphuric acid and 5 parts of alcohol. The resultant distillate is rectified and mixed with 10 to 40 per cent of alcohol and 5 to 50 per cent of a suitable hydrocarbon oil to produce a fuel mixture having a specific gravity of 0.730 to 0.780. (Australian Patent 8816, A. DE FEO LOPEZ, Argentina; June 10, 1919.)

Manufacturing Oil Pastes.—To obviate drying the material when preparing oil pastes, such as white lead from lead precipitates, a predetermined quantity of borate of manganese, not exceeding 0.5 per cent, is added to the wet precipitate, after which oil is added and the mass is subjected to thorough mechanical working and mixing to expel the water and cause the oil to combine with the precipitate. (Australian Patent 8323, H. P. FLETCHER, New South Wales; July 8, 1919.)

---

[1] Duane and Wendt, *Physical Review*, vol. 10, pp. 116-128 (1917).
[2] S. C. Lind, *J. Am. Chem. Soc.*, vol. 41, p. 545 (1919).
[3] F. L. Usher, *J. Chem. Soc.*, vol. 97, p. 400 (1909).
[4] Irving Langmuir, *J. Am. Chem. Soc.*, vol. 34, pp. 860, 1310 (1912); vol. 36, p. 1708 (1914); vol. 37, p. 417 (1915).
[5] Rays of Positive Electricity, Longmans (1919).
[6] A. J. Dempster, *Phil. Mag.*, vol. 31, pp. 438-443 (1916).

Paint for Tropical Climates.—A paint which consists of 43.5 parts of precipitated lead carbonate, 6.5 parts of finely powdered dolomite, 36.5 parts of precipitated zinc hydroxide, 3 parts of infusorial earth, 4 parts of finely precipitated aluminum hydroxide, 0.5 parts of cobalt acetate, and 6 parts of precipitated calcium sulphate, which are dehydrated and mixed with 6 parts of polymerized linseed oil, 4 parts of refined perilla oil, 6.5 parts of refined linseed oil, and 1.5 parts of Chinese tung oil. (Australian Patent 8833, E. MAJOR and J. A. MAJOR, New South Wales; July 22, 1919.)

Hydrocarbon Cement.—A cement for building, paving, etc., in which pitch, tar, or other aromatic hydrocarbon having a specific gravity of not less than 1.1 is brought to a temperature of 120 to 180 deg. C., and mixed with from one to four times its volume of powdered metallic sulphates, such as calcium or magnesium sulphate. In a modification, the mixture is formed under pressure in a closed vessel to raise the boiling temperature, the volatile matter produced being utilized as fuel for the process. (Australian Patent 7487, W. S. BARRIE and L. CHADWICK, Queensland; July 29, 1919.)

Canadian Patents

For full specification address Commissioner of Patents, Ottawa, Canada

Leather Manufacture.—A process of treating leather which consists in covering the leather with a thin coating of oil heated to a temperature of approximately 150 deg. F., then allowing the oil to remain in contact with the leather for approximately 12 hours and until the temperature of the leather has cooled to approximately 80 deg. F., then applying a second coating of oil heated to approximately 150 deg. F., and again allowing the leather and oil to remain in contact and cool to a temperature of approximately 80 deg. F. for another 12-hr. period, and repeating the alternate heating and cooling processes until 5 or 6 coatings have been applied. (Canadian Patent 189,958, ALFRED J. HAWKINS, Montreal, Quebec; April 29, 1919.)

Potassium Extraction.—A process of producing a soluble salt of an alkali metal, which consists in treating a silicate containing said metal with uncombined phosphoric acid, thereby producing a double phosphate of said alkali metal, and an insoluble residue consisting only of constituents of the original silicate, separating said alkali phosphate from the insoluble residue, adding an acid which will replace the phosphoric acid in the salt, thus converting the alkali metal phosphate into the alkali metal salt of the other acid and freeing the phosphoric acid, and crystallizing the alkali metal salt of the added acid from the phosphoric acid and utilizing the recovered phosphoric acid to react upon fresh mineral containing said alkali metal. (Canadian Patent 191,260, FREDERICK D. S. ROBERTSON, Toronto, Ontario; July 1, 1919.)

Book Reviews

THE YEAR BOOK OF THE COKE OVEN MANAGERS' ASSOCIATION. 482 pp., including 169 pp. of tables and miscellaneous general information. London: Benn Bros., Ltd. Printed for private circulation only.

This year book is very creditable to the young British organization whose activities it records, especially considering the extraordinarily difficult conditions existing during the year 1918, which was the second year of the association's existence. The book includes 30 articles on subjects relating to by-product coking, of which 14 articles are printed in full, while the others are reported from various association addresses in the easy and interesting third person style so familiar in British publications. One-third of the book is taken up with mathematical, physical, and chemical tables and miscellaneous general information, even to the extent of income tax notes, all of which will undoubtedly make the volume useful as a handbook to the majority of its subscribers. Probably it is not intended to reproduce this material in subsequent annual issues. Naturally, most of the articles have reference to conditions resulting from the exigencies of the war, and many bear evidence of haste in preparation, which is surely pardonable under the circumstances. The recovery of benzol seems to have occupied the foreground in the meetings and discussions, for eight of the articles deal with various phases of this subject. In the reviewer's opinion, however, none of these articles gives new information of interest to American readers. In particular, the laboratory methods for the determination and testing of the benzols that have been developed on this side of the Atlantic have many points of advantage and superiority over those described in the year book.

Closely allied to the subject of benzol is that of the constituents of coal tar, to which two interesting articles are devoted. The first is a modified translation of Weger's paper "Uber Seltenere und Reinpräparate aus Steinkohlteer" (*Zeit. angew. Chem.*, XXII, I, pp. 338, 391). The translation has been modified and supplemented by Dr. P. S. Spielmann, so that it makes an admirable synopsis of practical information on the coal-tar substances. The second is a short report of a descriptive address by Dr. P. P. Bedson on "Coal-Tar Derivatives," dealing with general economic conditions, with examples of results of research in this industry. Ammonia recovery was the subject of discussion at three or four meetings, one of the most interesting addresses being made by Mr. E. Kilburn Scott on the "Manufacture of Ammonium Nitrate in Coke Oven Plants." In Mr. Scott's opinion, by-product coke plants can readily and profitably undertake the manufacture of nitric acid from a part of the ammonia which they produce and would thereby be enabled to convert all of their ammonia into ammonium nitrate.

Of special interest is the information given at several meetings relating to the use of coke-oven gas in gas engines, an important application with which American engineers have had comparatively little experience. Among other articles of technical interest are several on the subject of refractory materials used in coke-oven construction; a paper on the "Occurrences in the Oven During Carbonization," by D. V. Hollingworth; a report of Mr. E. M. Meyer's paper on the "Design and Layout of a Modern Coke Plant," and discussions of Boiler Feed Water, Coal Washing, and the Utilization of Low-Grade Fuels.

Of statistical importance is a complete list of by-product coke-oven plants in Great Britain, giving the name and address of each concern, the number and type of ovens, the by-products recovered, and the name of the coke-oven manager.

It is interesting and gratifying to note that the two principal themes that run consistently through the majority of addresses and discussions are appreciation of the importance of the chemist in the industry and consideration of ways and means for the organized improvement of the industry. In all discussions of the second theme, the first is recognized as being closely related and fundamentally necessary. The Coke Oven Managers' Association is to be congratulated on the broad-minded and far-seeing attitude which is maintained in considering the general problems of the industry.

F. W. SPERR, JR.

Personal

Mr. **HAROLD ADAMS**, who was formerly production manager of the New York plant of E. R. Squibb & Sons, has resigned to accept a position with the research laboratory of the U. S. Rubber Co., Waterbury, Conn.

Col. **F. J. M. AULD**, of the British Army, has resigned his position as professor of chemistry at Reading and is now with the research laboratory of the Anglo-Persian Oil Co., 15 St. Phillips Road, Surbiton, Surrey, England. Col. Auld will be remembered by many of the men in the service who came in contact with him while he was chief of the British Chemical Warfare Mission at Washington, for his pleasing personality and his thorough knowledge of matters pertaining to gas warfare. Col. Auld has recently received the Distinguished Service Medal from Gen. Pershing and was awarded the Order of the British Empire and a Brevet by his own government. The company with which he has now associated himself is building a large refinery in Wales.

Dr. **EDWARD BARTOW**, formerly Lieutenant-Colonel in the Sanitary Corps, connected with the Water Supply Service of the A. E. F., has resumed his former work as chief of the Illinois Water Survey Division.

Mr. **BERRY V. BUSH**, formerly head of the chemistry department at Friends Central School, Philadelphia, has been appointed research chemist in the organic research laboratory of the Eastman Kodak Co., Rochester, N. Y.

Mr. **H. E. CLEAVES** is now with the Charleston Chemical Co., Charleston, W. Va., as chief chemist, having left the Metal & Thermit Corp., Jersey City, N. J.

Mr. **H. W. CURRY** recently resigned from the Ozark Smelting & Mining Co., Coffeyville, Kan., to accept a position in the oxide department of the American Zinc, Lead & Smelting Co., Hillsboro, Ill.

Dr. **HARRY A. CURTIS**, formerly in the Federal Nitrogen Research Laboratory, is now on the chemical faculty of the Northwestern University, Evanston, Ill.

Mr. **ELLIOTT E. GEISINGER**, formerly of the Pfaudler Co., is now connected with the Firestone Tire & Rubber Co., Akron, Ohio, as industrial engineer.

Mr. **H. D. GIBBS** has resigned as chemist in charge of the color laboratory of the U. S. Bureau of Chemistry to accept a research position with E. I. duPont de Nemours & Co., at its Jackson Laboratories, Wilmington, Del.

Mr. **CHESTER G. GILBERT** has resigned from the Smithsonian Institution to accept a position on the staff of Arthur D. Little, Inc., of Cambridge, Mass., which has opened a Washington office in the Munsey Building, with Mr. Gilbert in charge.

Dr. **EDWARD S. JOHNSON**, formerly with the Solvay Process Co., has accepted the position of director of manufacture and chief chemist of the U. S. Color & Chemical Co., with main office in Boston and plant at Ashland, Mass.

Mr. **ROY G. KNICKERBOCKER** has accepted the position of superintendent of erection and operation of a new smelter and refinery for the Messina Development Co. of Transvaal, South Africa.

Mr. **J. A. LECLERC** has resigned as chemist-in-charge of the laboratory of plant chemistry of the Bureau of Chemistry, Washington, D. C., to accept a position with the Miner-Hillard Milling Co., Wilkes-Barre, Pa.

Mr. **J. R. LORENZ**, formerly in the research laboratory of William F. Mosser Co., Chicago, Ill., is now with the Northeastern Leather Co., Salem, Mass., as tanning chemist.

Mr. **W. H. MACMILLAN** has resigned as chief chemist of the Remington Typewriter Co., Ilion, N. Y., to accept a position in the metallurgical laboratory of the Halcomb Steel Co., Syracuse, N. Y.

Mr. **CHARLES A. MANN** has been appointed professor of industrial chemistry, School of Chemistry, University of Minnesota, Minneapolis, Minn.

Prof. **C. H. MATHEWSON** has been elected professor of metallurgy and metallography in the Sheffield Scientific School of Yale University.

Dr. **E. MILLER**, associate in chemistry at Johns Hopkins University, has resigned to take a position with the duPont Powder Co.

Mr. **NORVILLE C. PERVIER**, recently discharged from the U. S. Army, has returned to his former position as chief chemist of the Standard Chemical Company, Inc., Des Moines, Iowa.

Dr. **A. PIRELLI** has been elected president of an Italian Society of Chemical Industry which has been organized at Milan.

Dr. **ARTHUR B. RAY**, recently Captain in the Chemical Warfare Service, has joined the staff of the research laboratories of the National Carbon Co., Inc., Cleveland, Ohio.

Mr. **R. C. SHUEY** has resigned as assistant superintendent of Armour Soap Works to go into the engineering department of the Redmanol Chemical Products Co., Chicago, Ill.

Mr. **ALFRED H. WHITE**, formerly Lieutenant-Colonel and chief of the research section of the Nitrate Division of the Ordnance Department, has returned to his former position as professor of chemical engineering at the University of Michigan, but is retaining connection with the nitrogen fixation work as consulting engineer of the Ordnance Department.

Current Market Reports

The Non-Ferrous Metal Market

New York, Dec. 29:—The copper market has gained both in strength and in activity during the last week. Tin is practically the same in price. A steady demand for lead has stiffened the price.

		Cents Per Lb.
Copper, electrolytic		18.75
Aluminum, 98 to 99 per cent		33.00
Antimony, wholesale lots		9.75
Nickel, ordinary		42.00
Nickel, electrolytic		45.00
Tin, Straits, spot		53.25
Lead, New York, spot		7.50
Lead, E. St. Louis, spot		7.20
Silver	(Dollars per oz.)	1.33⅛

FINISHED METAL PRODUCTS

	Warehouse Prices Cents Per Lb.
Copper sheets, hot rolled	28.50
Copper sheets, cold rolled (over 14 oz.)	30.50
Copper bottoms	37.00
Copper rods	29.50
High brass wire and sheets	25.50
High brass rods	24.24
Low brass wire and sheets	28.25
Low brass rods	28.25
Brazed brass tubing	37.25
Brazed bronze tubing	42.00
Seamless copper tubing	32.00
Seamless bronze tubing	36.00
Seamless brass tubing	30.50

SCRAP METALS

	Cents Per Lb.
Aluminum, cast scrap	22½ – 23½
Aluminum, sheet scrap	21½ – 22½
Aluminum clippings	24½ – 26
Copper, heavy machinery comp.	14½ – 14¾
Copper, heavy and wire	13½ – 14
Copper, light and bottoms	12½ – 12¾
Copper, heavy cut and crucible	15½ – 16
Brass, heavy	7½ – 8½
Brass, casting	10½ – 10¾
Brass, light	5½ – 6½
No. 1 clean brass turnings	8½ – 8¾
No. 1 comp. turnings	11½ – 12
Tea lead	4.50 – 4.60
Lead, heavy	5.76 – 5.87
Zinc, scrap	4½ – 4¾

The Iron and Steel Market

Coal shortage is still a factor in restricting steel mill operations, but not to the extent of keeping operations below the rate obtaining just before the coal shortage developed. Rather the difficulty is that some of the capacity which the practical disappearance of the iron and steel strike would permit of being operated is held idle. On the whole there is considerably more capacity in operation now than when the coal shortage became a factor early in December. Coke shortage is as much of a factor in restricting operation of blast-furnaces as coal shortage is in the case of steel mills. For illustration, both the Bellaire and Mingo works of the Carnegie Steel Co., in the Wheeling district, had been idle since Sept. 22 on account of the iron and steel strike, which held on longer in the Wheeling district than anywhere else, and last week the Mingo works started but the Bellaire works remained down from lack of coke, a condition that will probably be remedied this week.

Coke Output Increasing

The by-product ovens have been steadily increasing their coke output as coal supplies increased, through getting back to normal coking time. The Carnegie Steel Co. is now about to put in operation two new batteries of ovens at the Clairton plant, 64 ovens each, recently completed. The original plant of ten batteries, 640 ovens, was completed and put in operation before the end of last year. The plant eventually is to comprise 20 batteries, the original plan having been to build ten batteries at the outset and the remaining ten at a considerably later time, but during the war two batteries of the last ten were set forward on the program. Apart from the plant of the Pittsburgh Crucible Steel Co., to be completed next summer, there is scarcely any construction of by-product ovens in progress. It is estimated that by-product ovens, in batteries of 50 to 100, would cost about $45,000 per oven, while the iron and steel industry cannot think of such new construction, apart from the item of cost, as long as it has not sufficient labor to operate in full its various existing facilities.

Market Quiet

The pig iron, unfinished steel and finished steel markets have been quiet for a week or ten days, making a sharp contrast with the feverish activity that has prevailed for two months or more. The quietness is the natural and invariable thing for the holiday season, but at the same time it is the unbroken experience of the past that after a "holiday dullness" the markets do not automatically resume their activity, fresh-compelling influences being requisite. Markets are not purely the resultant of statistics or the relation between supplies and requirements, but are distinctly affected by psychological influences. In the case of pig iron, with its advance of $10 to $12 a ton since last June, chiefly in the past few weeks, it may even be found that there was something more than normal psychology, possibly a little of "mob psychology" or the psychology of the crowd. The past week is the first for two months or more in which no noteworthy advances in pig iron have occurred. Declines in the near future, however, are probably out of the question, for all furnaces are sold up for several months ahead and would have no occasion to cut prices even if demand were extremely light. In the eastern Pennsylvania and Buffalo districts there was considerable buying by speculative interests and there is always a possibility of speculators endeavoring to unload at unsuitable times.

Premiums for Steel

While the finished steel markets have been much quieter in the past week, greater delivery premiums have been paid in a number of instances. A fortnight ago plates for early delivery were in general at about 2.75c., higher prices being paid only on very small lots, but two or three lots in tonnages running into four figures have lately been sold at 3c. The Carnegie Steel Co. has again bid 2.50c. on plates for the Navy Department, the lot now in negotiation being 10,000 tons. The March 21 or "stabilized" price is 2.65c., and the Steel Corporation does not in any instance ask more. Some large independents are quoting 2.75c. even for late deliveries, while prices above that are for very early deliveries only. Steel bars in small lots have been bringing as high as 3c., the regular price being 2.35c., but some relatively conservative interests are on a 2.50c. basis, despite the adherence of the Steel Corporation and some independents to the 2.35c. price. Sheets, both black and galvanized, have been done at $10 premium for first quarter.

The Chemical Market

New York, December 26, 1919.

A perspective of the current year's market shows great activity among users of chemicals and a mighty effort on the part of the producer to meet this increased demand of a post-war period. Among the primary causes of the present high scale of prices are the unsettled labor conditions, scarcity of raw materials and a lack of adequate transportation facilities.

The past week has been a period of resting before the take-off for the new year, all branches being quiet. *Salammoniac* remains firm at 12¾-14c. per lb., car lots, and 13¾-15½c. in less than car lots. There is some English salammoniac on the market at 11c. per lb., but it is the opinion of some that England will place an embargo on the exporting of this item to the United States owing to a scarcity of ammonia liquor. *Caustic soda* has jumped from $3.80 to $4.10-$4.35 per cwt., while *formaldehyde* is scarce at 20-37c. per lb. *Sodium bichromate* is easier with a new low mark of 22c., against 25c. per lb. of last week. Quotations on *alcohol* are unobtainable. There is a considerable supply of ethyl and denatured, but the prices being paid by the patent medicine men are prohibitive and drive off any other likely buyers. Further difficulties arise from the uncertainty as to the stand the Government will take regarding denatured alcohol. Some former distillers have put up large denaturing plants.

Dimethylaniline in the coal-tar products is active at 88-90c. per lb. compared with 60-92c. of the previous report. Japan at present is a heavy buyer of this item. *Aniline oil* has had considerable inquiry and is easier than last week, the low price dropping from 35c. to 34½c. per lb., drums included, while *aniline salts* is unobtainable, though quoted at 43-45c. The demand on *benzol*, pure water white, at 27-31c. per gal., *toluol* in tanks 28c. per gal., and *naphthalene* continues heavy, with prices firm.

Naval stores are firm, with a reported firmer Southern market; prices remain unaltered. The lack of cables from English and Indian markets due to the holiday season celebration leaves the same prices standing from last week in the *crude rubber* market. *Vegetable oils* have been dull caused by the buyers balking at the present scale of prices.

In the miscellaneous materials *barytes*, domestic white floated, is especially active at $35-$40 per ton, with the entire production filling domestic demand. *Fuller's earth*, domestic and imported, is unobtainable at present, with the nominal quotation of $25-$35 on the former and $35-$45 per ton on the latter still holding. *Domestic chalk*, extra light, claimed to be lighter than the imported extra light, is quoted at 5-5½c. per lb., while the light is being sold at 4½-5c.

Ferro-alloys are firm and quiet. Among the ores and semi-finished products *tungsten* has had some movement, owing to those who have this item stocked clearing their books; prices remain about the same.

Domestic producers of *ferromanganese*, after making fairly large sales at their advanced price of $120, delivered, have now advanced to $130, on which basis the market is quiet. English is now quoted at the advanced price of $125, c.i.f., but in the circumstances there would be little demand at that figure. *Spiegeleisen* is quoted at $40, furnace, for spot and $41 to $42 for futures.

Electric-furnace *ferrosilicon* is quiet at recently advanced prices, makers quoting $90 for 50 per cent and $140 to $150 for 75 per cent, delivered Pittsburgh, valley and Cleveland districts. Blast-furnace ferrosilicon is quiet, with the following prices ruling on bessemer ferrosilicon: 10 per cent, $59.50; 11 per cent, $62.80; 12 per cent, $66.10, f.o.b. Jackson, Ohio.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, NOV. 30, 1919

		Carlots	Less Carlots
Acetic anhydride	lb.	......-......	$0.60 -$0.65
Acetone	lb.	$0.20 -......	.21 -......
Acid, acetic, 28 per cent	cwt.	2.50 -$2.75	3.00 - 3.25
Acetic, 56 per cent	cwt.	5.00 - 5.50	6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	12.50 -13.50	13.50-15.50
Boric, crystals	lb.	.13 - .13½	.13½- .14½
Boric, powder	lb.	.13 - .13½	.13½- .14½
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	1.50 - 1.75	2.00 - 2.50
Hydrofluoric, 52 deg.	lb.	.12 -......	.14 -......
Lactic, 44 per cent. tech	lb.	.11 - .14	.12 - .16
Lactic, 22 per cent. tech	lb.	.05 - .06	.05½- .07
Molybdic, C. P	lb.	......-......	4.00 - 4.25
Nitric, 40 deg.	lb.	.06 - .06½	.07 - .08½
Nitric, 42 deg.	lb.	.07 - .07½	.08 -......
Oxalic, crystals	lb.	.23 - .25	.25 - .30
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 -......	.10 - .14
Picric	lb.	.30 - .35	.40 - .50
Pyrogallic, resublimed	lb.	......-......	2.30 - 2.60
Sulphuric, 60 deg., tank cars	ton	12.00 - 16.00	......-......
Sulphuric, 60 deg., drums	ton	17.00 -......	22.00 -......
Sulphuric, 60 deg., carboys	ton	20.00 -......	29.00 -......
Sulphuric, 66 deg., tank cars	ton	17.00 -18.00	22.00 -23.00
Sulphuric, 66 deg., drums	ton	20.00 -21.00	25.00 -26.00
Sulphuric, 66 deg., carboys	ton	25.00 -......	30.00 -40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 -......	26.00 -......
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 -......	32.00 -......
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 -......	35.00 -......
Tannic, U. S. P.	lb.	......-......	1.35 - 1.45
Tannic (tech.)	lb.	......-......	.42 - .55
Tartaric, crystals	lb.	......-......	.73 - .74
Tungstic, per lb. of WO	lb.	......-......	1.20 - 1.40
Alcohol, Ethyl	gal.	4.80 - 4.95	5.50 -......
Alcohol, Methyl	gal.	1.30 -......	1.33 - 1.38
Alcohol, denatured, 188 proof	gal.	.66 -......	.68 - .70
Alcohol, denatured, 190 proof	gal.	.62 -......	.64 - .66
Alum, ammonia lump	lb.	.03½- .04½	.04½- .04¾
Alum, potash lump	lb.	.08 - .08½	.09 - .09½
Alum, chrome lump	lb.	.15 - .16	.18 - .20
Aluminum sulphate, commercial	lb.	.01¾- .02	.02¼- .02½
Aluminum sulphate, iron free	lb.	.02¼- .03	.03¼- .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08 -......	.08½- .09
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	......-......	.30 - .35
Ammonium carbonate, powder	lb.	.13 - .13½	.14 - .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½- .13	.13½- .14
Ammonium chloride, granular (gray salammoniac)	lb.	.12 - .12½	.13 - .13½
Ammonium nitrate	lb.	.10 -......	.11 - .12
Ammonium sulphate	lb.	.05 -......	.06 -......
Amyl acetate	gal.	......-......	3.65 - 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	......-......	.09 - .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	......-......	......-......
Barium chloride	ton	85.00 -......	90.00 -100.00
Barium dioxide (peroxide)	lb.	.22 -......	.24 -......
Barium nitrate	lb.	.09½- .10½	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.03 - .03½	.03½- .04
Bleaching powder (see calcium hypochlorite)		......-......	......-......
Blue Vitriol (see copper sulphate)		......-......	......-......
Borax (see sodium borate)		......-......	......-......
Brimstone (see sulphur, roll)		......-......	......-......
Bromine	lb.	......-......	.65 - .75
Calcium acetate	cwt.	2.00 - 2.05	2.10 -......
Calcium carbide	lb.	......-......	.04½- .05
Calcium chloride, fused, lump	ton	19.00 -25.00	30.00 -40.00
Calcium chloride, granulated	lb.	.01½- .01¾	.02 - .02¼
Calcium hypochlorite (bleaching powder)	cwt.	......-......	2.75 - 3.75
Calcium peroxide	lb.	......-......	1.50 - 1.70
Calcium phosphate, monobasic	lb.	......-......	.75 -......
Calcium sulphate, precipitated	lb.	......-......	.09 - .09½
Carbon bisulphide	lb.	.05½-	.06 - ....
Carbon tetrachloride, drums	lb.	.10 - .11	.12 - .14
Carbonyl chloride (phosgene)	lb.	......-......	.75 -......
Caustic potash (see potassium hydroxide)		......-......	......-......
Caustic soda (see sodium hydroxide)		......-......	......-......
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 - .05½	.08 -......
Cobalt oxide	lb.	......-......	1.50 - 1.55
Copperas (see iron sulphate)		......-......	......-......
Copper carbonate, green precipitate	lb.	......-......	.28 - .31
Copper cyanide	lb.	......-......	.65 - .70
Copper sulphate, crystals	lb.	.08½- .08¾	.09 - .09½
Cream of tartar (see potassium bitartrate)		....	......-......
Epsom salt (see magnesium sulphate)		......-......	......-......
Formaldehyde, 40 per cent	lb.	......-......	.32 - .37
Glauber's salt (see sodium sulphate)		......-......	......- ....
Glycerine	lb.	......-......	.24½- .26
Iodine, resublimed	lb.	......-......	4.50 -......
Iron oxide, red	lb.	......-......	.03 - .20
Iron sulphate, (copperas)	cwt.	1.00 -......	1.20 - 1.50
Lead acetate, normal	lb.	....	.12½- .14½
Lead arsenate (paste)	lb.	......-......	.13 - .17
Lead nitrate, crystals	lb.	......-......	.85 - .86½
Litharge	lb.	......-......	.09½- .10½
Lithium Carbonate	lb.	......-......	.50 -......
Magnesium carbonate, technical	lb.	......-......	.13 - .14½
Magnesium sulphate, U. S. P.	100 lb.	2.00 - 2.63	2.75 - 3.00
Magnesium sulphate, commercial	100 lb.	1.75 -......	2.00 - 2.50
Nickel salt, double	lb.	.14 -......	.15 -......
Nickel salt, single	lb.	.12 -......	.15 - .16
Phosgene (see carbonyl chloride)		......-......	......-......
Phosphorus, red	lb.	......-......	.75 - .90
Phosphorus, yellow	lb.	......-......	.35 - .37
Potassium bichromate	lb.	.26 - .27	.30 - .33
Potassium bitartrate (cream of Tartar)	lb.	......-......	.55 - .60
Potassium bromide, granular	lb.	......-......	.50 - .65
Potassium carbonate, U S. P.	lb.	.60 -......	.65 - .70
Potassium carbonate, crude	lb.	.25 -......	.26 -......
Potassium chlorate, crystals	lb.	.17 - .20	.21 - ...
Potassium cyanide, 98-99 per cent.	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.30 - .32	.35 - .40
Potassium iodide	lb.	......-......	3.55 - 3.60
Potassium nitrate	lb.	.19 -......	.21 -......
Potassium permanganate	lb.	......-......	.55 - .65
Potassium prussiate, red	lb.	......-......	1.05 - 1.15
Potassium prussiate, yellow	lb.	...... -......	$0.45 -$0.55
Potassium sulphate	ton	225.00 -......	......-......
Rochelle salts (see sodium potas. tartrate)		......-......	......-......
Salammoniac (see ammonium chloride)		......-......	......-......
Sal soda (see sodium carbonate)		......-......	......-......
Salt cake (sodium sulphate)	ton	17.00 -21.00	......-......
Silver cyanide	oz.	......-	1.19 -......
Silver nitrate	oz.	......-	.76½- ....
Soda ash, light	100 lb.	2.00 -......	2.05- ....
Soda ash, dense	100 lb.	2.25 - 2.35	2.50 - 2.75
Sodium acetate	lb.	.05½- .06½	.07 - .08
Sodium bicarbonate	100 lb.	2.60 -......	2.75 - 3.00
Sodium bichromate	lb.	......-......	.38 - .42
Sodium bisulphate (nitre cake)	ton	3.00 - 8.00	10.00 -......
Sodium bisulphite	cwt.	1.80 - 1.90	2.00 - 2.10
Sodium borate (borax)	lb.	.08 - .09	.08½- .09
Sodium carbonate (sal soda)	100 lb.	1.35 - 1.50	1.50 - 1.75
Sodium chlorate	lb.	.15 -......	.16 - .18½
Sodium cyanide, 96-98 per cent.	lb.	.30 -......	.31 - .34
Sodium fluoride	lb.	.14 -......	.15 - .16
Sodium hydroxide (caustic soda)	100 lb.	......-......	..... - 3.80
Sodium molybdate	lb.	2.50 -......	3.25 -......
Sodium nitrate	100 lb.	......- 3.25	3.75 - 4.00
Sodium nitrite	lb.	.15 - .17	... - .18
Sodium peroxide, powdered	lb.	......-......	.30 - .32
Sodium phosphate, dibasic	lb.	.03½- .04	.04½- .05
Sodium potassium tartrate (Rochelle salts)	lb.	......-......	.43 - .45½
Sodium prussiate, yellow	lb.	.24½- .26	.27½- .28
Sodium silicate, solution (40 deg.)	lb.	.01¾- .02	.02 - .02¼
Sodium silicate, solution (60 deg.)	lb.	.02¼- .03	.03½- .04¼
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.15 - 1.25	1.50 - 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	......-......	.05 - .06
Sodium sulphite, crystals	lb.	.03½-......	.04 - .06
Strontium nitrate, crystals	lb.	.25 -......	.28 -......
Sulphur chloride	lb.	.05½-......	.06 -......
Sulphur, crude	ton	22.00 -......	......-......
Sulphur dioxide, liquid, cylinders	lb.	......-......	.10 - .12
Sulphur (sublimed), flour	100 lb.	3.10 -......	3.40 - 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 -......	3.15 - 3.40
Tin bichloride (stannous)	lb.	.44 -......	.46 - .50
Tin oxide	lb.	......-......	.60 -......
Zinc carbonate, precipitate	lb.	......-......	.20 -......
Zinc chloride, gran.	lb.	.12½-......	.13½- .14
Zinc cyanide	lb.	.49 -......	.50 -......
Zinc dust	lb.	.09 - .11	.11 - .14
Zinc oxide, dry American	lb.	......-......	.09½- .12
Zinc sulphate	lb.	.03½- .03¾	.04 - .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.32	—	.50
Aniline oil, drums extra	lb.	.34	—	.35
Aniline salts	lb.	.37	—	.....
Anthracine, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.00	—	1.15
Benzidine, base	lb.	1.75	—	.....
Benzidine, sulphate	lb.	.90	—	1.15
Benzoic acid, U. S. P.	lb.	.90	—	1.10
Benzoate of soda, U. S. P.	lb.	.80	—	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27	—	31
Benzol, 90%, in drums (100 lb.)	gal.	.25	—	.29
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	3.75	—	4.50
Beta naphthol, sublimed	lb.	.75	—	.80
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.80	—	.85
Cresylic acid, 95-97%, dark, in drums	gal.	.85	—	.90
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.40	—	2.25
Dimethylaniline	lb.	.80	—	.85
Dinitrobenzol	lb.	.26	—	.37
Dinitroclorbenzol	lb.	.25	—	.30
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.32	—	.36
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.65
Diphenylamine	lb.	.58	—	.75
H-acid	lb.	1.60	—	1.75
Metaphenylenediamine	lb.	1.15	—	1.80
Monochlorbenzol	lb.	.12	—	.15
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.06½	—	.07½
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	.75	—	1.25
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.40	—	.45
Nitro-toluol	lb.	.27	—	.20
Ortho-amidophenol	lb.	3.00	—	4.25
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.90	—	1.25
Ortho-nitro-toluol	lb.	.25	—	.40
Ortho-toluidine	lb.	.25	—	.45
Para-amidophenol, base	lb.	2.50	—	3.50
Para-amidophenol, HCl	lb.	2.50	—	3.25
Para-dichlor-benzol	lb.	.15	—	.18
Paranitraniline	lb.	.95	—	1.10
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.50	—	4.00
Paratoluidine	lb.	1.75	—	2.50
Phthalic anhydride	lb.	1.50	—	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12½	—	.16
Pyridin	gal.	2.00	—	2.50
Resorcin, technical	lb.	3.75	—	4.00
Resorcin, pure	lb.	6.50	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45	—	.60
Salicylic acid, U. S. P.	lb.	.45	—	.50
Salol	lb.	.90	—	.95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.22	—	.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30

Tolidine	lb.	$1.70	—	$2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	28	—	.....
Toluol, in drums	gal.	.32	—	.30
Xylidine, drums, 100 gal	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.42	—	$0 44
Beeswax, refined, yellow	lb.	47	—	.48
Beeswax, white pure	lb.	.63	—	.66
Carnauba, No. 1	lb.	.80	—	.83
Carnauba, No. 2, regular	lb.	.65	—	.78
Carnauba, No. 3, North Country	lb.	.44	—	.50
Japan	lb.	.18½	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	.07
Paraffine waxes, crude, scale 124-126 m.p.	lb.	....	—	.06½
Paraffine waxes, refined, 118-120 m.p.	lb.	....	—	.09
Paraffine waxes, refined, 128-130 m.p.	lb	.09½	—	.10½
Paraffine waxes, refined, 133-135 m.p.	lb.	....	—	.12
Paraffine waxes, refined, 135-137 m.p.	lb.	....	—	.13
Stearic acid, single pressed	lb.	.23	—	.26
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1 25
Pine oil, pure, dest. dist.	gal.	1 00
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.47
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal	1.00
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal	....
Pinewood creosote, ref.	gal.	.51

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$17 00	—	$17.50
Rosin E-I	280 lb.	17.55	—	18.25
Rosin K-N	280 lb.	19.75	—	23.00
Rosin W. G.-W W.	280 lb.	22.50	—	24.25
Wood rosin, bbl.	280 lb.	17.00	—	17.50
Spirits of turpentine	gal.	1.65	—	1.66
Wood turpentine, steam dist.	gal.	1.63	—	....
Wood turpentine, dest. dist.	gal.	1.50	—	....
Pine tar pitch, bbl.	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	14.90
Retort tar, bbl.	280 lb.	15.00	—	15.25
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.95	—	1.12
Rosin oil, fourth run	gal.	1.05	—	1.15

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.53	—	$0.54
Upriver coarse	lb.	....	—	.35½
Upriver caucho ball	lb.	.34½	—	.35½
Plantation—First latex crepe	lb.	.51½	—	....
Ribbed smoked sheets	lb	.51½	—	....
Brown crepe, thin, clean	lb.	.46½	—	.47½
Amber crepe No. 1	lb.	.49	—	....

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.19
Castor oil, AA, in bbls.	lb.	.21½	—	.22
China wood oil, in bbls.	lb.	.22½	—	.23
Cocoanut oil, Ceylon grade, in bbls.	lb.	.17½	—	.18½
Cocoanut oil, Cochin grade, in bbls.	lb.	.19½	—	.20
Corn oil, crude, in bbls.	lb.	.19	—	.21½
Cottonseed oil, crude (f.o.b. mill)	lb.	.18	—	.19
Cottonseed oil, summer yellow	lb.	.22	—	.27
Cottonseed oil, winter yellow	lb.	.23	—	.28
Linseed oil, raw, car lots	gal.	....	—	1.87
Linseed oil, raw, tank cars	gal.	1.80	—	1.83
Linseed oil, boiled, car lots	gal.	....	—	1.90
Olive oil, commercial	gal.	2.50	—	2.80
Palm, Lagos	lb.	.17	—	.17½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.23½	—	.23½
Peanut oil, refined, in bbls.	lb.	.26	—	.28
Rapeseed oil, refined in bbls.	gal.	1.45	—	1.60
Rapeseed oil, blown, in bbls.	gal.	1.60	—	....
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.17½	—	.22
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½	—	.15½

FISH

Winter pressed Menhaden	gal.	$1.20	—	.....
Yellow bleached Menhaden	gal.	1.23	—	....
White bleached Menhaden	gal.	1.25	—	.....
Blown Menhaden	gal.	1.26	—	....

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	30.00	—	50.00
Casein	lb.	.16	—	.18
Chalk, English, light	lb.	.05	—	07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	$ .04	—	$ .05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	13.50	—	17.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	30.00	—	35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, TN	lb.	1.10	—	1.15
Shellac, D. C.	lb.	.....	—	....
Shellac, V. S. O.	lb.	.....	—	....
Shellac, Diamond I	lb.	.....	—	....
Shellac, orange, fine	lb.	1.25	—	.....
Shellac, orange, superfine	lb.	1.20	—	1.30
Shellac, A.C. garnet	lb	1.10	—	.....
Shellac, bleached, bone dry	lb.	1.35	—	.....
Shellac, bleached, fresh ground	lb.	1.10	—	1.15
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	1,000	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.40
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon	lb.	0.21	—	.50
Ferro-manganese, 70-80% Mn	gross ton	110.00	—	130.00
Spiegeleisen, 16-20% Mn	gross ton	33.00	—	45.00
Ferro-molydenum, per lb. of Mo	lb.	3.00	—	3.50
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, $C_2.O_3$	unit	$0.60	—	$0.85
Chrome ore, 48% and over	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	—	7.50
*Coke, furnace, f.o.b. ovens	net ton	6.00	—	6.50
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines	net ton	.....	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

* Government prices.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.80
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	6.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	50.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	40.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	1.75
Linseed oil, 5 gal. cans	gal.	1.90
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

California

EMERYVILLE (Oakland P. O.)—W. J. Miller, architect, 417 Market St., San Francisco, will soon receive bids for the construction of a 2-story factory, for the American Rubber Co., Emeryville. Estimated cost, $100,000.

LOS BANOS—The City Trustees have purchased the plant of the West San Joaquin Water Co. and plan to move same here and install tank, tower and filter in same.

Colorado

DENVER—The state plans to install an oil shale laboratory in the University of Colorado. Estimated cost, $20,000.

Connecticut

NAUGATUCK—Lockwood, Green & Co., architects, 101 Park Ave., New York City, will receive bids about Jan. 7 for the construction of a factory for the Naugatuck Chemical Co., c/o architects. Estimated cost, $70,000.

NEW BRITAIN—Landers, Frary & Clark (manufacturers of electric hardware), Commercial and Center Sts., have awarded the contract for the construction of 4 buildings, including a 3 story, 40 x 68 ft. tempering building, on South Standley St., to the Torrington Building Co., 197 Water St., Torrington. Estimated cost, $49,000.

Illinois

ALTON—The Illinois Glass Co. has purchased a plot at North Crawford and Wrightwood Aves., Chicago, and plans to build a new plant on same. Estimated cost, $250,000.

CHICAGO—The Channel Chemical Co., 58 East Washington St., has awarded the contract for the construction of a 4 story, 150 x 300-ft. factory on Western Ave. and West 45th St., to Davidson & Weiss, 53 West Jackson Blvd. Estimated cost, $450,000.

WHEATON—The city will soon receive bids for the construction of a sewage disposal plant, including filter beds. Estimated cost, $200,673. L. J. Ruddock, city engr.

Indiana

INDIANAPOLIS — The Van Briggle Chemical Co., 429 North Capitol Ave., plans to construct a 3-story, 160 x 200-ft. display and factory building at 16th St. and Capitol Ave. Estimated cost, $125,000. Charles E. Bacon, Merchants Bank Bldg., architect.

New Jersey

NEW BRUNSWICK—The city plans to issue $13,000 bonds for the installation of additional units at the filtration plant.

TRENTON—The International Gasofoam Co., 564 East State St., plans to build an oil plant here. Estimated cost, $50,000. L. E. Warren, Brokaw Bldg., New York City, interested.

Maryland

BALTIMORE—The American Sugar Refining Co., 117 Wall St., New York City, is having plans prepared for the construction of a sugar refining plant on Locust Pt. harbor front. Estimated cost, $8,000,000. Ralph Stubbs, general manager.

BALTIMORE—Louis Miller, 5 Lloyd St., will receive bids about Jan. 15 for the construction of a 2-story, 45 x 50-ft. dairy and cold storage building at 5-7-9 Lloyd St. Estimated cost, $50,000. G. R. Callis, Melvin Ave., Catonsville, architect.

CURTIS BAY—(Baltimore P. O.)—The Curtis Bay Copper & Iron Works will build a 1-story, 75 x 230-ft. addition to the structural iron and copper works plant on Beach St. Estimated cost, $100,000.

Michigan

NORTHVILLE—The Detroit Board of Health, 233 Antoine St., Detroit, plans to construct a 2-story, 28 x 36-ft. laboratory 2 miles north of here, in connection with the group of buildings to be constructed at the proposed Detroit Municipal Tuberculosis Sanitarium. Complete laboratory equipment will be installed in same. Stratton & Snyder, 1103 Union Trust Bldg., Detroit, architects.

Minnesota

DULUTH—The Minnesota Steel Co. has had plans prepared for the construction of an extension to the blast-furnace plant, here. Project includes 3 additional blast-furnaces, 14 open-hearth furnaces and a unit of 16 soaking-pit furnaces. Estimated cost, $10,000,000.

Ohio

BARBERTON—The Portage Rubber Co. is having plans prepared for the construction of an office building and power plant in the western section of the city. Estimated cost, $200,000.

CLEVELAND—Edward Stattuck, commissioner of purchases, city hall, received bids for the construction of a sewage disposal plant in the easterly section of the city, from the American Construction Co., Marion Bldg., $258,957; McHugh Bros., West 37th St., $338,730; Masters-Mullen Construction Co., Electric Bldg., $400,486. Plans include a laboratory, and a 140 x 142-ft. screen grit chamber building.

DAYTON—The Wuichet Fertilizer Co., Irwin St., has awarded the contract for the construction of a 2-story, 60 x 80-ft. and 60 x 110-ft. factory on Irwin St., to Joseph Lowes, Schwind Bldg. Estimated cost, $75,000.

NEWARK—The Parish Rubber Co. has awarded the contract for the construction of a 2-story, 110 x 180-ft. rubber factory to the Bellfontaine Steel Co., Bellfontaine. Estimated cost, $100,000.

Pennsylvania

WILKES-BARRE—J. Linn Johnson, Ross St., plans to construct a 2-story, 50 x 150-ft. machine and welding shop at Ross and Gildersleeve Sts. Estimated cost, $45,000.

Rhode Island

PROVIDENCE—The Gorham Manufacturing Co. (silversmith), Reservoir Ave., has awarded the contract for the construction of a 1-story, 30 x 120-ft. factory addition on Adelaide Ave., to J. W. Bishop Co., Foster St., Worcester. Esimated cost, $15,000.

Wisconsin

GREEN BAY—The John Hoberg Paper Co., Elm St., has purchased a site at 12th and Main Sts., and plans to build a 4-story, 60 x 250-ft. paper mill on same. Estimated cost, $250,000.

WAUWATOSA—Milwaukee county plans to construct an extension to the sewage disposal tank. Estimated cost, $30,000. The Board of Administration is in charge of the work. W. S. Shields, 1201 Hartford Bldg., Chicago, engineer.

Ontario

BARTON—The township has voted the Firestone Tire & Rubber Co., Firestone Park, Akron, Ohio, a fixed assessment as an inducement to the establishment of a tire factory here. The city of Hamilton has also passed a bylaw providing for a sewer and watering system to the proposed plant. Estimated cost, $1,500,000.

SUDBURY—The High School Board plans to construct a 3-story high school. Chemical and physical laboratories will be installed in same. Estimated cost, $200,000.

Coming Meetings and Events

The American Ceramic Society will hold its annual meeting in Philadelphia, Pa., Feb. 23-26.

The American Chemical Society will hold its annual meeting April 13 to 16 inclusive, in St. Louis.

The American Electrochemical Society will hold its spring meeting in Boston, April 8, 9, and 10.

The American Institute of Mining and Metallurgical Engineers will hold its spring meeting in New York, Feb. 16-19.

The National Foreign Trade Convention will be held in San Francisco, May 12 to 15.

The Mining and Metallurgical Society of America will hold a meeting in New York Jan. 13.

Industrial Notes

The Speare Chemical Products Co., New York, has opened a branch office in Boston, Mass., at 27 School St., under the personal supervision of Mr. B. Goldstein.

The Oliver Continuous Filter Co. announces the removal of its New York offices to the Aeolian Bldg. The rapidly increasing business of the company requires much larger space than it was able to obtain at the old quarters. Mr. Gordon Walker is in charge.

The Crocker-Wheeler Co., of Ampere, N. J., has just inaugurated a plan of training for its foremen and other factory supervisors which is of considerable interest. A group of 62 men has been formed to pursue a three months' course in modern production methods, which comprises the study of specially prepared text units, the solution of problems relating to the units, and the discussion of this material at six bi-weekly meetings held after hours in the plant. These meetings will provide an opportunity to bring home the application of the work to the special problems of Crocker-Wheeler Co. production. At each meeting a lecture will be delivered by an experienced production man and the lectures will be followed by a round-table discussion. Included in the group, besides foremen, are the superintendent and three assistant superintendents, which insures that the meetings will be highly resultful to the members of the class. The subjects to be studied are: How to promote team work in the shop; handling men in a way to increase production and promote harmony; how production should be organized; efficient purchasing, scheduling, routing, repairing, etc.; keeping down the overhead by stricter cost keeping; major problems of management. The course is under the direction of the Business Training Corporation of New York City, which supplies the study material and the class instruction.

Mr. Earl E. Eby, sales manager of the Hyatt Roller Bearing Co., has been appointed to the board of directors of Hyatt, Ltd., a new company formed to market the Hyatt bearings in Europe. Mr. Eby will devote his entire time to this work in New York City. Mr. G. M. Helmstaedter, formerly Chicago district manager, has been promoted to the position of sales manager to fill the vacancy formed by Mr. Eby's new duties.

New Publications

The Orifice as a Means of Measuring Flow of Water Through a Pipe. By Raymond E. Davis and Harvey H. Jordan. Bull. 109, Engineering Experiment Station, published by the University of Illinois, Urbana, Ill.

Trading With Australasia. Published by the Guaranty Trust Co. of New York.

Chemical Literature and Its Use. By Marion E. Sparks. Notes of twelve lectures in chemistry 92 required of third year students in chemistry and chemical engineering at the University of Illinois.

Descriptive Bulletin of the Department of Metallurgical Research, State School of Mines, University of Utah. Published by the University of Utah, State School of Mines, in co-operation with the U. S. Bureau of Mines.

The Fabric of Civilization. A short survey of the cotton industry in the United States. Published by the Guaranty Trust Co., of New York.

3 2044 102 908 12